MERRIMACK RIVER BASIN

MANCHESTER, NEW HAMPSHIRE

# HIGH SERVICE DISTRIBUTION RESERVOIR

N H 00296

NHWRB 150.11

# PHASE I INSPECTION REPORT

# NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

APRIL 1979

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r program reads: Phase I Inspection Report, National Dam Inspection Program; ver, the official title of the program is: National Program for Inspection of Federal Dams; use cover date for date of report.

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nchester, New Hampshire

TRACT (Continue on reverse side if necessary and identify by block number)

e dam os a concrete lined earth and rock fill embankment that is used as a ter supply. The dam has a maximum height of 35 ft. It is small in size with high hazard potential. In the event of a failure, several downhill residences uld be threatened. The reservoir is in good condition. No displacement ttlement, or other signs of major distress were observed at the reservoir.

# HIGH SERVICE DISTRIBUTION RESERVOIR
# NH 00296

MERRIMACK RIVER BASIN
HILLSBOROUGH COUNTY, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

| | |
|---|---|
| Identification No.: | NH 00296 |
| NHWRB No.: | 150.11 |
| Name of Dam: | HIGH SERVICE DISTRIBUTION RESERVOIR |
| City: | Manchester |
| County and State: | Hillsborough County, New Hampshire |
| Stream: | None |
| Date of Inspection: | November 1, 1978 |

## BRIEF ASSESSMENT

High Service Distribution Reservoir is a concrete lined earth and rock fill embankment that is used as a water supply reservoir for the city of Manchester, New Hampshire. The total crest perimeter of the embankment is approximately 1,570 feet. The maximum embankment height from downstream toe to crest is 35 feet while the water depth in the reservoir is maintained at 24 feet or less. The reservoir is owned by the city of Manchester and is operated by the Manchester Water Works.

The reservoir is located near the top of Oak Hill in Manchester and has no contributory drainage area other than the surface of the reservoir. The embankment crests all extend above the surrounding ground so no surface water can get into the reservoir. The maximum impoundment of 63 acre feet and maximum height of 35 feet place the reservoir in the SMALL size category. In the event of a failure, several downhill residences would be threatened resulting in a HIGH hazard potential classification.

Since the reservoir has no natural drainage area, the only natural "flood" that could result in overtopping of the reservoir would be a 18 inch rainfall in conjunction with a malfunction of the inflow/outflow system. A more likely overtopping condition, however, is a malfunction of the inflow/outflow control system or an incorrect manual operation at the water treatment plant.

The reservoir is in GOOD condition at the present time. No displacement, settlement, or other signs of major distress were observed at the reservoir. It is recommended that

...stered professional engineers be retained to study the ...urce and extent of the seepage at the west embankment and to examine the concrete liner after the reservoir has been drawn down. Recommended remedial measures include the repair of spalled concrete on the concrete portions of the dam, removal of shrubs, trees and their roots from the embankment slopes and replacement with suitable compacted backfill, formalizing the weekly site visit procedures, repair of the eroded embankment on the south side, backfilling animal burrows, retaining the current annual detailed inspection program, and instituting formal emergency warning system to inform downstream residents of potentially hazardous conditions.

The above recommendations and improvements should be implemented within two years of receipt of this report by the owner.



William S. Zoino
N.H. Registration 3226

Nicholas A. Campagna, Jr.
California Registration 21006

# PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the Test Flood should not be interpreted as necessarily posing a highly inadequate condition. The Test Flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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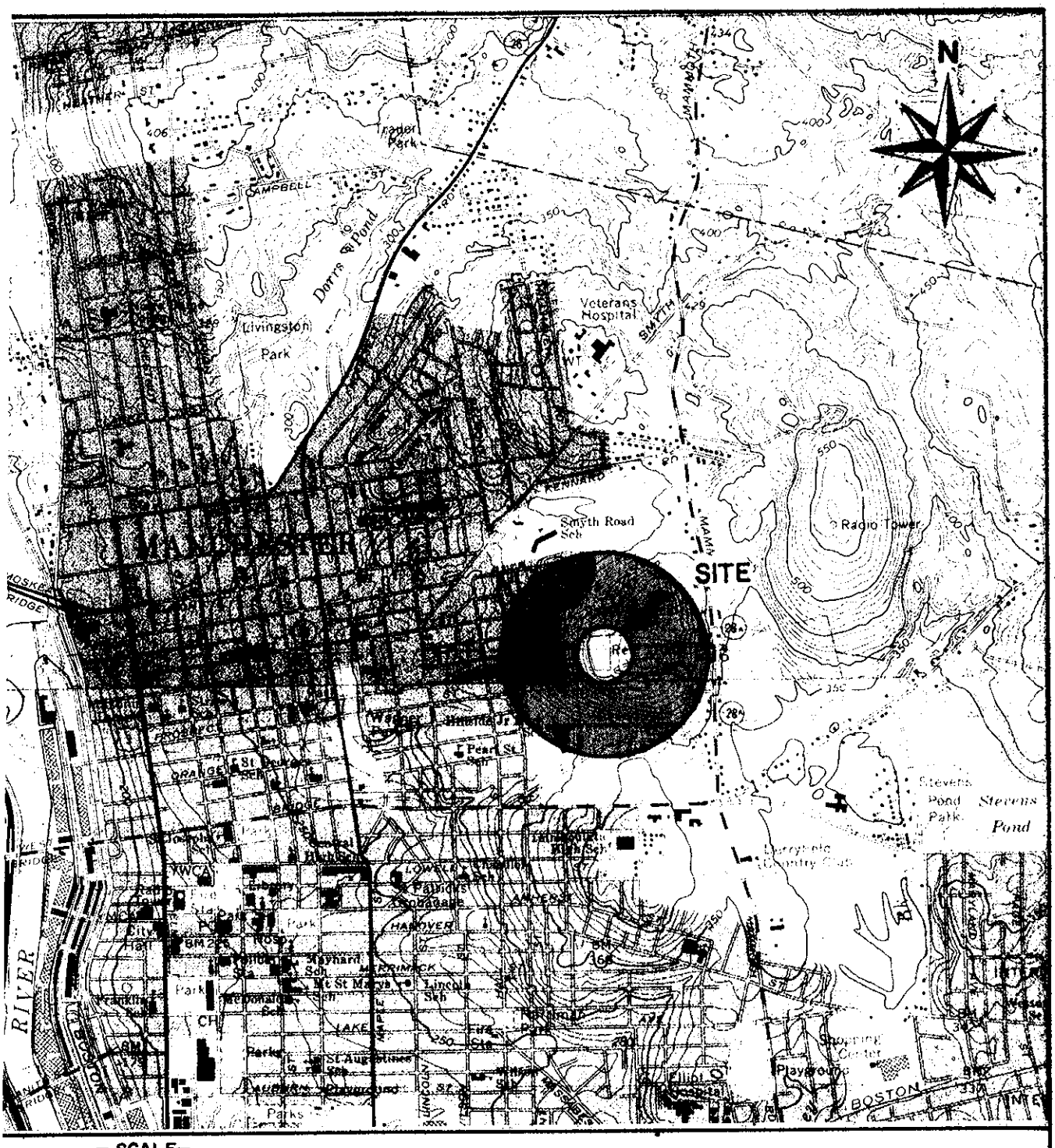
Overview of reservoir from east side looking towards Manchester

Overview of tiers on west side from toe of embankment




— SCALE —
1000 2000 4000

FROM: USGS MANCHESTER NORTH & SOUTH QUADRANGLE MAPS

| | |
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| GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC.<br>GEOTECHNICAL CONSULTANTS<br>NEWTON UPPER FALLS, MASS. | U.S. ARMY ENGINEER DIV. NEW ENGLAND<br>CORPS OF ENGINEERS<br>WALTHAM, MASS. |

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

# LOCUS PLAN

FILE No. 22201

H.S. DISTRIBUTION RESERVOIR — NEW HAMPSHIRE

| | |
|---|---|
| SCALE | AS NOTED |
| DATE | NOVEMBER 1978 |

# PHASE I INSPECTION REPORT

# HIGH SERVICE DISTRIBUTION RESERVOIR

## SECTION 1

## PROJECT INFORMATION

### 1.1 General

#### (a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to GZD under a letter of November 28, 1978 from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW 33-79-C-0013 has been assigned by the Corps of Engineers for this work.

#### (b) Purpose

(1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) Update, verify, and complete the National Inventory of Dams.

#### (c) Scope

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dam.

## 1.2 Description of Project

### (a) Location

The reservoir is located approximately 2,000 feet north and 1,500 feet west of the intersection of Mammoth Road (Route 28A) and Bridge Street in Manchester, New Hampshire. It is accessible by an access road intersecting Mammoth Road just north of the previously described intersection. The reservoir is located near the top of a hill overlooking the city of Manchester. The portion of USGS Manchester North, N.H. quadrangle presented previously shows this locus. Figure 1 of Appendix B presents a detail of the site developed from the inspection visit and the quadrangle map.

### (b) Description of Dam and Appurtenances

The reservoir consists of earth fill, rock fill, and natural embankments which are lined with concrete. The easterly portion of the concrete lining is founded on bedrock while the western portion is supported by earth and rock fill embankments. The embankment reaches a maximum height at the west end of approximately 35 feet. The average daily inflow and outflow is 14 mgd.

A 30-inch cast iron force main which reduces to 24 inches south of the embankment and continues to the gate well carries water into the reservoir. There is a 24-inch cast iron outlet with gate structure.

#### 1) Reinforced Concrete Liner

The outside perimeter of the concrete lining is approximately 1,570 feet long. The top of the liner has been extended for a height of 1.5 feet above the top of the surrounding embankment. The sloping walls and bottom of the liner are 8 inches thick while the 1.5 foot parapet wall extension is 9 inches thick. The easterly portion of the liner, which is founded on bedrock, has been placed on a slope of 3 horizontal to 12 vertical. The portion of the liner on the earth embankments is at a slope of 2 horizontal to 1 vertical. The bottom slab and the sloping sidewalls contain numerous expansion joints consisting of copper and rubber expansion strips and poured asphalt joint sealer.

A toe drain system, which consists of 4 inch vitreous clay tile, has been placed under the westerly portion of the liner and outlets at the base of the west embankment near the outlet main. A 4 inch V.C. tile toe drain system has been placed around the perimeter of the reservoir and outlets into five observation wells at the base of the embankment. One outlet is located on the southerly side while the remainder are located on the west side.

The surface of the reservoir is kept covered with either a neoprene or butyl rubber protective cover fastened to pontoons to protect treated water from contamination. The cover is fastened to the top of the perimeter parapet wall with a series of anchor bolts which hold down a steel plate over the cover. Photo No. 2 in Appendix C shows a detail of this connection.

(2) Embankments

The embankments are combination earth and rock fill. The interior embankment slopes are primarily earth fill and are at a slope of 2 horizontal to 1 vertical while the exterior slopes are rock fill slopes and are sloped at 1.5 horizontal to 1 vertical. The exterior slopes have 10 foot wide benches at elevations 476 and 486. The exterior slopes have hand placed riprap protection. The crest of the dam is approximately 17 feet wide and is paved.

(3) Inlet Gate Structure

The inlet gate structure is framed with timber and clad with corrugated metal sliding. It is located approximately midway along the crest of the south embankment. The structure is approximately 9 feet square at its base and is founded on a reinforced concrete slab, which spans over a 25 foot deep pit.

The structure houses a hand operated Rodney Hunt bench stand with a non-rising stem for operating the 24 inch inlet gate. A telemetering device with a sensing rod is also located within the structure. This system continuously records the reservoir pool stage at the treatment plant.

(4) Outlet Gate Structure

This structure is located on the west side of the reservoir and is approximately 10 feet long, 9 feet high, and 34 feet deep. The pit walls vary from 18 inches at the top to 24 inches at the base. The 24 inch gate is operated from the top of the deck slab by a hand operated Rodney Hunt Company bench stand. Two 8-inch gates are manually operated at the pit base and are used to drain the reservoir.

(c) Size Classification

The reservoir's maximum impoundment of 63 acre feet and maximum height of 35 feet place the reservoir in the SMALL size category as defined in the "Recommended Guidelines."

(d) Hazard Potential Classification

In the event of a failure of the reservoir 3 to 5 downstream residences are within 100 feet of the toe of the embankment. The possibility of significant economic loss and possible loss of life place the reservoir in the HIGH hazard potential classification.

(e) Ownership

The reservoir is owned by the city of Manchester and is operated through the Manchester Water Works. Mr. Kitridge of the Manchester Water Works is responsible for the overall operation of the reservoir. He can be reached by telephone at 603-668-3830.

(f) Operator

The reservoir is operated by the Manchester Water Works through its plant engineer, Mr. Robert Beaurivage. Much of the day-to-day operation is performed by the plant foreman, Mr. MacDonald. The telephone number for the water treatment plant is 603-624-4349 or 603-624-4348.

(g) Purpose of Dam

The reservoir serves as a water supply for the city of Manchester.

(h) Design and Construction History

The reservoir was built in 1934 to supplement the reservoir located immediately south of the new reservoir.

The reservoir increased the storage capacity of the Manchester water system by 17 million gallons. The post construction changes have been relatively minor being limited to the addition of some pipes and the installation of the reservoir cover. The reservoir cover was installed around 1970.

(i) Normal Operational Procedures

The normal operational procedure is to maintain the water level between 1.5 and 6.5 feet below the top of the parapet wall. The level of the reservoir is monitored continuously by the Manchester Water Works at its water treatment plant through the telemetered recording system. The treatment plant is about one mile east of the reservoir on the western shore of Massabesic Lake. The information on water levels is recorded on a continuous circular strip chart which is replaced weekly. In addition the strip chart is read hourly and the level recorded. This reading is performed 24 hours a day so the reservoir level is noted at least once an hour by an employee of the Manchester Water Works. A backup alarm system is also located in the treatment plant in the event the reservoir level rises above elevation 500.9 (1.5 feet below top of wall). The normal range of water levels fluctuates about 5 feet.

1.3 Pertinent Data

(a) Drainge Area

The reservoir is located near the top of a hill, and the embankments keep surface water from flowing into the reservoir. The reservoir is fed by a 24 inch main leading from the water treatment plant. There is no contributing drainage area other than the pond (3.2 acres). Water is normally provided by pumping.

(b) Discharge at Damsite

1) Outlet Works

The discharge for the reservoir is the 24 inch supply main that leads to the Manchester Water distribution system.

2) Maximum Flood: Not applicable

3) Spillway capacity at maximum pool elevation:

Not applicable

(4) Gated spillway capacity at normal pool elevation:

Not applicable

(5) Gated spillway capacity at test flood elevation:

Not applicable

(6) Total spillway capacity at test flood elevation:

Not applicable

(7) Total project discharge at test flood elevation:

Not applicable

(c) Elevation (ft. above MSL)

(1) Streambed at centerline of dam: Not applicable (NA)

(2) Maximum tailwater: NA

(3) Upstream portal invert diversion tunnel: NA

(4) Recreation pool: NA

(5) Full flood control pool: NA

(6) Spillway crest (gated) NA

(7) Design surcharge (original design): 500.9

(8) Top Dam: 502.4

(9) Test flood design surcharge: NA

(d) Reservoir

(1) Length of maximum pool: 420 ft.

(2) Length of recreation pool: NA

(3) Length of flood control pool: NA

(e) Storage (acre-feet)

(1) Recreation pool: NA

(2) Flood control pool: NA

(3) Operational pool: 52

(4) Top of dam: 63

(5) Test flood pool: NA

(f) Reservoir Surface (acres)

(1) Recreation pool: NA

(2) Flood-control pool: NA

(3) Operational: 3 ±

(4) Test flood pool: NA

(5) Top dam: 3 ±

(g) Dam

(1) Type: Earth and rockfill embankments with concrete lined slopes and bottom

(2) Length: 1570 ft. along perimeter of parapet wall

(3) Height: 35 ft.

(4) Top width: 17 ft.

(5) Side slopes: U/S 2 horizontal to 1 vertical
D/S 1.5 horizontal to 1 vertical

(6) Zoning: Earthfill with downstream rockfill zone

(7) Impervious Core: NA

(8) Cutoff: None

(9) Grout curtain: None

(10) Other: NA

(h) Diversion and Regulating Tunnel: NA

(i) Spillway: NA

(j) Regulating Outlets

The discharge from the reservoir is controlled by a 24 inch gate which is hand operated by a Rodney Hunt Company bench stand. The invert of the gate valve is elevation 470.8. There are also two 8 inch gate valves for an 8 inch drain which discharges into the sewer system. These two gates are normally closed and are used to drain the reservoir for maintenance purposes.

## SECTION 2 - ENGINEERING DATA

### 2.1 Engineering Records

Several original design drawings are available for the reservoir and are included in Appendix B. No original calculations are available.

### 2.2 Construction Records

No construction drawings or records of value are available for the reservoir.

### 2.3 Operational Records

Records of the operation of the reservoir are kept at the water treatment plant. These records include water level readings taken continuously on a circular strip chart recorder.

### 2.4 Evaluation of Data

(a) Availability

The relative completeness of the design drawings and the apparent accuracy of the drawings warrants a satisfactory evaluation for availability.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data.

(c) Validity

Since the observations of the inspection team generally confirm the data contained in the design drawings, a satisfactory evaluation for validity is assigned.

## SECTION 3 - VISUAL OBSERVATIONS

### 3.1 Findings

#### (a) General

High Service Distribution Reservoir is in GOOD condition at the present time. Some maintenance of the embankments is required, and the sources of the seepage observed along the west embankment need to be investigated further.

#### (b) Concrete Lining

Minor concrete spalling was noted at some vertical expansion joints around the perimeter of the structure (Photo 2). Vertical and horizontal effloresced hairline cracks were also observed at some locations. The joint spalls and minor cracking are attributed to temperature changes. An expansion joint in the parapet wall, located at the southwest corner, is completely distorted. The distortion is a result of faulty construction, but this does not appear to be a detriment at this time. Spalling has occurred adjacent to the joint.

The reservoir cover is extensively patched and, in all probability, is not completely sealed.

#### (c) Inlet Gate Structure

Operating personnel indicated that all gates are in good operating condition at the present time.

The bench stand for the 24 inch force main gate is in good condition. The wood frame structure is in good condition despite some rusting of the metal siding.

#### (d) Outlet Gate Structure

The outlet structure is in good condition. Hairline cracks completely cover the top slab. These cracks are attributed to improper curing and weather protection during placement. Minor surface spalling was noted on the vertical face of the adjacent parapet wall. This spalling is attributed to moisture intrusion which has been subjected to alternating freeze and thaw cycles. The bench stand is well lubricated and is in good condition. The operating wheel has been removed to preclude unauthorized use.

(e) Embankment

In general, the embankment is in good condition. The rock slope protection is generally in good condition with no major areas of sloughing or settlement. Some areas where maintenance work needs to be performed are noted below.

The crest of the dam is paved and is cracked. The southerly side of the crest near the inlet structure is eroded and settlement of the protective slope paving has resulted. This is attributed to poor drainage control.

The slope protection on the south embankment has some dips and bulges. Occasional small shrubs or trees are growing out of the slope.

The west embankment is in good condition (overview photo). No significant areas of sloughing of the rock slopes are visible. The rock face is smooth with occasional small shrubs or trees growing in this slope. The lower berm at the southwest corner of the embankment has some depressions and some erosion of fines over the slope.

The north embankment (photo 1) has a rodent hole near the west embankment. The slope protection on the middle berm is not as neatly placed as in other portions of the embankment. Several shrubs and small trees are growing out of the embankment.

During the site inspection visit no seepage was observed at the toe of the embankment. However, on a later site visit (December 20, 1978) two areas of seepage were noted. The first wet area was approximately 20 feet long and was located at the northwest corner of the embankment. The second area of seepage was at the toe of the west embankment, and the wet area was about 35 feet long. The seepage rate for both areas is estimated between 1 and 2 gpm. The wet areas were located outside the chain link fence surrounding the embankment (see p. B-2 for locations).

3.2 Evaluation

High Service Distribution Reservoir is in GOOD condition at the present time. The concrete lining and gate structures are in good condition. Some minor spalling and cracking was

observed and these areas should be repaired. Because the cover was in place, the major portion of the concrete liner could not be observed. The embankment is in good condition although some maintenance work is required. In particular irregular rip rap faces should be evened out, and shrubs and trees on the slopes should be removed along with their roots. The seepage should be investigated further to determine its source and extent.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 Procedures

The inflow into the reservoir is controlled by the 24 inch main leading from the City of Manchester water treatment plant on nearby Massabesic Lake. The water level in the reservoir is normally maintained in a 5 foot range. The normal water level does not exceed a height of 1.5 feet below the top of the parapet wall. Automatic alarms sound at the treatment plant if the water level gets too high. The outlet gate is always left open.

### 4.2 Maintenance of Dam

There are two basic maintenance procedures performed at the reservoir. A yearly detailed inspection is performed in the spring to assess the condition of the reservoir's various components. The reservoir is not normally drained at the time of these inspections. Major and minor repairs are based largely on the results of this inspection. Weekly site visits are made by personnel of the water treatment plant to observe the reservoir and its facilities.

### 4.3 Maintenance of Operating Facilities

The operating facilities appear to be well maintained and are in operable condition.

### 4.4 Description of Any Warning System in Effect

No written formal emergency warning procedure is in effect. In case of an emergency the water treatment personnel would notify local civil defense authorities who would effect an evacuation.

### 4.5 Evaluation

In general the operating and maintenance procedures are good. It is recommended that the weekly site visits be a formalized inspection of the reservoir with a checklist that needs to be filled out. It is also recommended that a formal written emergency warning procedure be established.

## SECTION 5 - HYDROLOGY/HYDRAULICS

### 5.1 Evaluation of Features

#### (a) General

The High Service Distribution Reservoir is part of the water supply system for the City of Manchester. The 17 million gallon reservoir is used primarily to equalize operating pressures rather than as a storage facility. The reservoir is concrete lined with a floating rubber cover to prevent contamination of the treated water.

Treated water is pumped from the treatment plant on nearby Massabesic Lake via a 30 inch cast iron force main which reduces to 24 inches just south of the reservoir embankment. The flow through this main is normally controlled by an automatic system at the treatment plant. However, it can be operated manually at the reservoir.

The outflow from the reservoir is through a 24 inch cast iron supply main. This is the only major outlet or spillway on this reservoir. The control gate is normally kept fully open and discharges directly into the Manchester municipal water supply system.

The only inflow to the reservoir is from the treatment plant. None of the surrounding area drains into the reservoir. Thus, the "drainage area" is equal to the "reservoir area" of 3.2 acres.

This reservoir provides approximately 40 percent of the total water supply storage for the Manchester system. The average demand in the system is about 13 mgd. Thus, the reservoir, when full, can hold the equivalent of about thirty hours of demand. The reservoir could thus be emptied in thirty hours by normal Manchester demand if the inflow and other supply sources in the system were shut off.

#### (b) Design Dat

The data sources available for the High Service Distribution Reservoir include a set of plans provided by the Board of Water Commissioners of the city of Manchester and a series of inspection reports from the files of the New Hampshire Water Resources Board (NHWRB).

(c) Experience Data

The reservoir is part of the high pressure water supply system for Manchester. It provides service storage to meet the varying supply demands of the system and serves to equalize operating pressures.

(d) Visual Observations

The reservoir is located on top of Oak Hill on the eastern side of Manchester City limits. There are 3 to 5 houses within 100 feet of the toe of the western embankment and several other houses within a few hundred feet of the embankments of the reservoir.

The only flow into the reservoir is via the 24 inch force main. The only major outlet is the 24 inch supply main. There is also an 8 inch outlet drain which is normally closed. This drains directly into the city sewer and storm drain system. This 8 inch outlet is used to drain the reservoir for maintenance.

(e) Test Flood Analysis

Phase I hydrologic investigations within the dam safety inspection program normally focus on the ability of the dam to safely pass an appropriately large flood. These studies usually follow the guidelines recommended by the Corps of Engineers. Given the special nature of the reservoir (no drainage and no spillway), the guidelines are not applicable for this case.

Since there are no areas draining to the pond, no natural "floods" need to be considered. The worst case of natural flow to the reservoir would be directly from rainfall over the reservoir. Since the maximum pool elevation is 18 inches below the top of the parapet wall. only a storm of over 18 inches in conjunction with malfunction of the inflow/outlet system would cause overtopping.

A more likely overtopping condition is a malfunction of the inflow/outflow control system or an incorrect manual operation at the water treatment plant. This could lead to flow over the parapet wall and embankment. The water would flow to the properties west of the reservoir. These flows would eventually enter the storm drain system in Manchester or flow on the street to the Merrimack River. The warning system should provide the required

information for the operator at the water treatment plant. Furthermore, as soon as the flow started over the top, the property owners downstream would notice the flow and would notify the operator before any major flows would develop.

The size classification for the reservoir is SMALL, while the hazard potential, because of the reservoir's location and the potential for significant economic damage and loss of life at the homes to the west in the event of a failure, is HIGH.

The result of the hydrologic and hydraulic investigation is that overtopping could result only if several malfunctions of the inflow/outflow system were to occur simultaneously. Even if overtopping did occur, it is not likely that serious damage would occur because the downstream residents would notify the operator before major damage could occur.

(f) Dam Failure Analysis

There is no well defined water course immediately "downstream" of the reservoir. A dam break wave would spread out as it moved down the hill. The detailed hydraulic analyses required to provide quantitative measures of the downstream hazard from a break of this reservoir's embankments are beyond the scope of these Phase I investigations. However, a major break in the west embankment could potentially cause significant economic losses and result in some deaths in a group of 3 to 5 houses immediately below. The damage and lives endangered would be a function of the width, depth, location of the break, and the time of day when failure occurred.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

(a) Visual Observations

The field investigations revealed no significant displacement or distress that would warrant preparation of structural stability calculations based on assumed sectional properties and engineering factors.

(b) Design and Construction Data

The design drawings would be helpful in a stability calculation if an analysis were necessary. The lack of data on embankment properties and foundation soil properties would be a significant drawback, however.

(c) Operating Records

No evidence of instability of the reservoir has been noted for operation of the reservoir under normal water levels.

(d) Post Construction Changes

The minor post construction changes at the reservoir have not affected the structural stability of the reservoir.

(e) Seismic Stability

The reservoir is located in Seismic Zone No. 2 and, in accordance with recommended Phase I guidelines, does not warrant seismic analyses.

## SECTION 7 - ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

### 7.1 Dam Assessment

(a) Condition

High Service Distribution Reservoir is in GOOD condition at the present time. Some minor maintenance and operational changes should be performed as outlined below.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Urgency

The recommendations and improvements listed herein should be implemented by the owner within two years of receipt of this Phase I Report.

(d) Need for Additional Investigations

Additional investigations should be performed by the owner as outlined in Paragraph 7.2 below.

### 7.2 Recommendations

It is recommended that a registered professional engineer be retained to conduct an investigation of the source and extent of the seepage noticed at the toe of the west embankment.

It is also recommended that a registered professional engineer inspect the concrete liner after drawdown of the reservoir.

### 7.3 Remedial Measures

It is recommended that the following remedial measures be undertaken by the owner:

(a) Repair the spalled concrete observed on the concrete portions of the reservoir.

(b) Remove all shrubs, trees and their roots from the slopes of the embankments and backfill with suitable well compacted fill.

(c) Formalize the inspection performed during the weekly site visits to include a routine that the inspector should follow. This may include a checklist of items that should be observed.

(d) Repair the embankment on the south side where some erosion and settlement has occurred.

(e) Retain the current annual detailed technical inspection and review system with particular attention to future seepage that may occur.

(f) Institute a formal written emergency warning system to notify downstream residents in case hazardous conditions should arise at the reservoir.

(g) Backfill animal burrows.

7.4 Alternatives

There are no meaningful alternatives to the above recommendations.

# APPENDIX A

## VISUAL INSPECTION CHECKLIST

# INSPECTION TEAM ORGANIZATION

Date: November 1, 1978

NH 00296
HIGH SERVICE DISTRIBUTION RESERVOIR
Manchester, New Hampshire
Not on watercourse
NHWRB No. 150.11

Weather: Clear, 50°F

## INSPECTION TEAM

| | | |
|---|---|---|
| Nicholas Campagna | Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) | Team Captain |
| Robert Minutoli | GZD | Soils |
| Andrew Christo | Andrew Christo Engineers (ACE) | Structural |
| Paul Razgha | ACE | Concrete |
| Guillermo Vicens | Resource Analysis, Inc. | Hydrology |

The inspection team was accompanied by a representative from the City of Manchester Water Treatment Plant.

CHECK LISTS FOR VISUAL INSPECTION

| AREA EVALUATED | BY | CONDITION & REMARKS |
|---|---|---|
| RESERVOIR EMBANKMENT | | |
| Crest elevation | NAC | 502.4 MSL (Top of parapet wall) |
| Current reservoir level | | 495.6 MSL |
| Maximum reservoir level | | 500.9 MSL |
| Surface cracks | | Considerable pavement cracking |
| Pavement condition | | Alligator cracks in pavement; erosion at the southerly side opposite outlet structure |
| Movement or settlement of crest | | Minor settlement opposite inlet structure due to drainage erosion |
| Vertical alignement | | No deficiencies noted |
| Horizontal alignment | | Slight bulges on downstream slope, may be due to placement of riprap |
| Condition at abutment and concrete structures | | No deficiencies noted |
| Indications of movement of structural item on slope | | None noted |
| Trespassing on slopes | | Small rodent hole at southwest corner of downstream slope. Small trees growing on slope |
| Sloughing or erosion of slopes | NAC | Minor erosion of lower berm at southwest corner |

CHECK LISTS FOR VISUAL INSPECTION

| AREA EVALUATED | BY | CONDITION & REMARKS |
|---|---|---|
| Rock slope protection | NAC | On downstream slope; good condition except for two local loose areas at the lower berms at the northwest portion of the northern embankment and the southwest corner |
| Unusual movement or cracking at or near toes | | None noted |
| Unusual embankment or downstream seepage | | None noted on day of inspection; however, on Dec. 20, 1978 when the reservoir level was 3.3 feet higher, two seeps along toe of west embankment with flows of 1 to 2 gpm. Seep was at the northwest end and at the dogleg near the middle of the west embankment |
| Piping or boils | | None noted, seepage appears clear |
| Foundation drainage features | NAC | Tile drains under downstream toe |
| CONCRETE RESERVOIR | | |
| Condition of concrete | AC | In general, good |
| Spalling | | Minor at isolated expansion joints and on vertical face of parapet wall adjacent to outlet supply pit |
| Erosion | | None noted |
| Cracking | | Isolated minor horizontal and vertical cracks on parapet wall |
| Rusting or staining of concrete | AC | None noted |

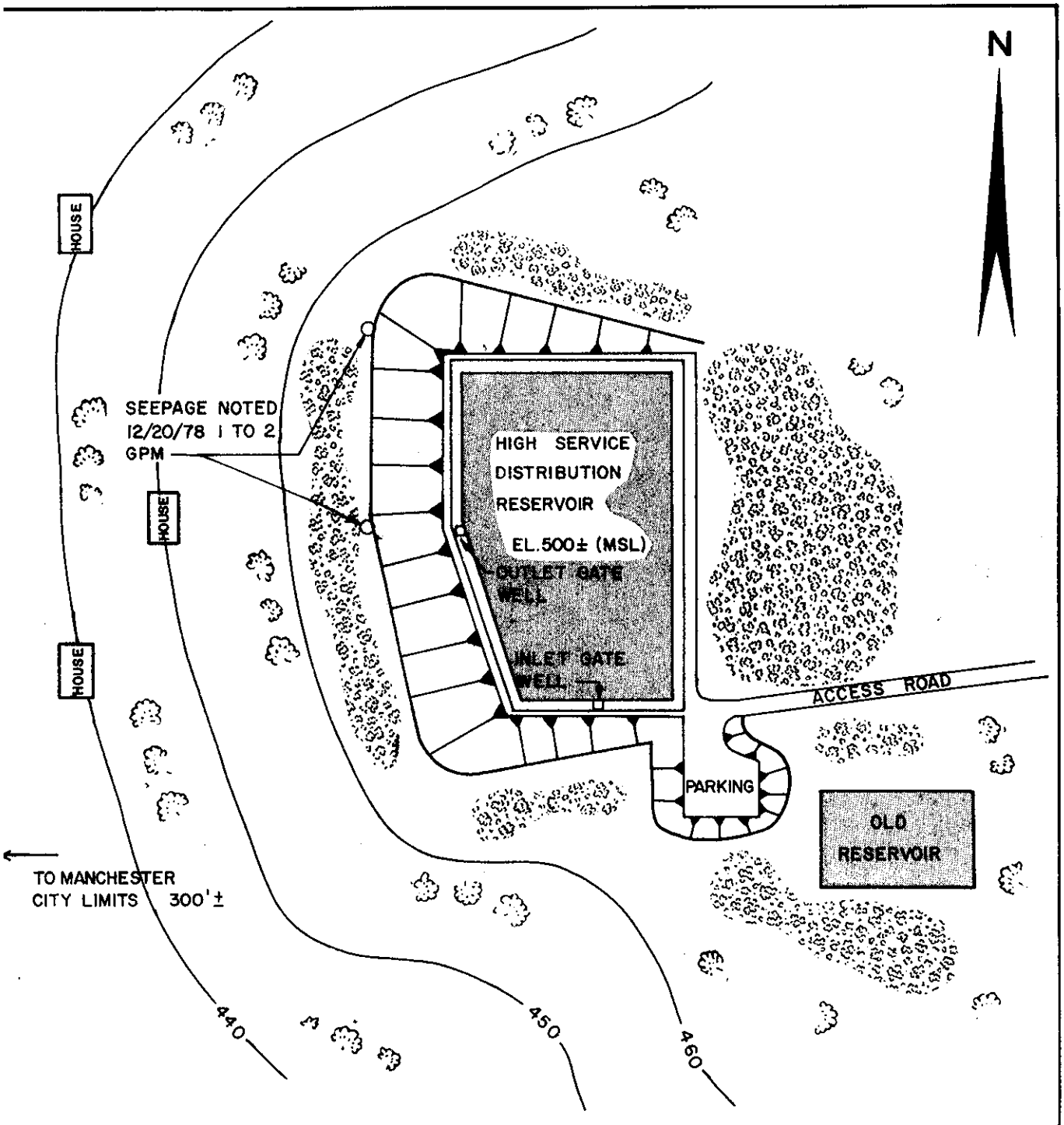
CHECK LISTS FOR VISUAL INSPECTION

| AREA EVALUATED | BY | CONDITION & REMARKS |
|---|---|---|
| Visible reinforcing | AC | None noted |
| Efflorescence | | Minor |
| Seepage | | None noted |
| Protective cover | AC | High degree of patching |
| GATE STRUCTURES | | |
| A. Force Main Inlet Structure | | |
| Building structure | PR | Fair. Corrugated metal cladding rusted |
| Bench stand operator | | Good condition |
| Telemetering system | | Operable |
| Gates | | No deficiencies noted |
| B. Supply Outlet Structure | | |
| Gates | | No deficiencies noted |
| Bench stand operator | | No deficiencies noted |
| Concrete slab | | |
| Condition of concrete | | Completely covered with random hairline cracks |
| Access hatch | PR | No deficiencies noted |
| OPERATION AND MAINTENANCE FEATURES | | |
| A. Reservoir Regulation Plan | | |
| Normal procedure | AC | Water levels in reservoir monitored continuously by telemetering system. Chart observed every hour. Direct observations made weekly |

CHECK LISTS FOR VISUAL INSPECTION

| AREA EVALUATED | BY | CONDITION & REMARKS |
|---|---|---|
| Emergency procedures | NAC | Inflow lines can be closed manually if automatic control fails |
| Compliance with designated plan | | Adequate |
| 3. Maintenance | | |
| Quality | | Annual technical inspection to evaluate maintenance need |
| Adequacy | NAC | Well maintained |

## APPENDIX B




| | |
|---|---|
| GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC.<br>GEOTECHNICAL CONSULTANTS<br>NEWTON UPPER FALLS, MASS. | U.S. ARMY ENGINEER DIV. NEW ENGLAND<br>CORPS OF ENGINEERS<br>WALTHAM, MASS. |

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

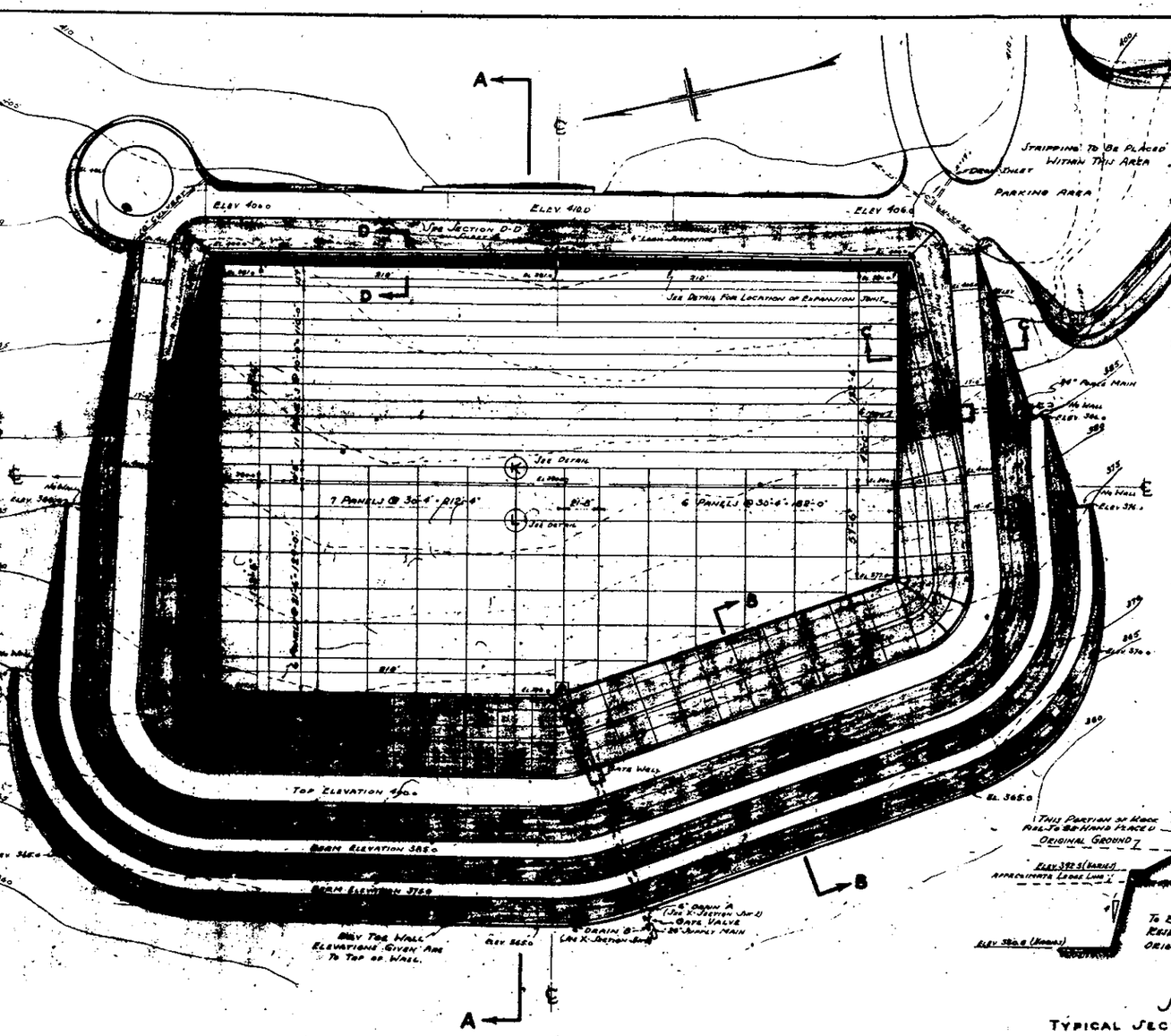
# SITE PLAN

FILE No. 2201

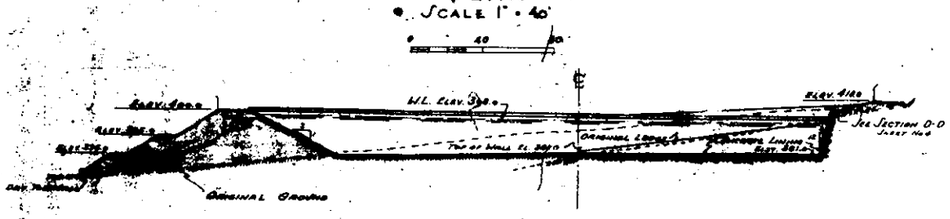
H.S. DISTRIBUTION RESERVOIR — NEW HAMPSHIRE

SCALE 1" ≈ 200'

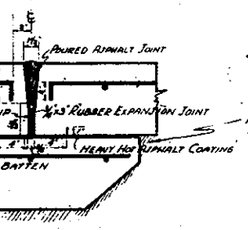
DATE NOVEMBER 1978



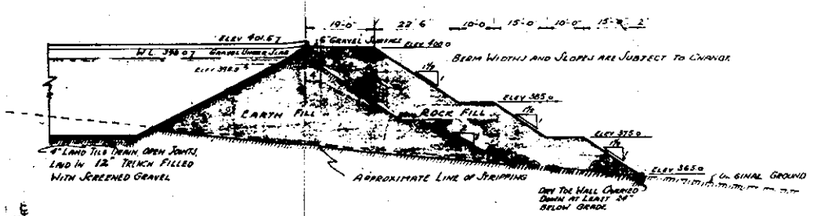

PLAN
SCALE 1" = 40'




SECTION A-A
SCALE 1" = 40




TYPICAL JOINT DETAIL
SCALE 1½" = 1'-0"



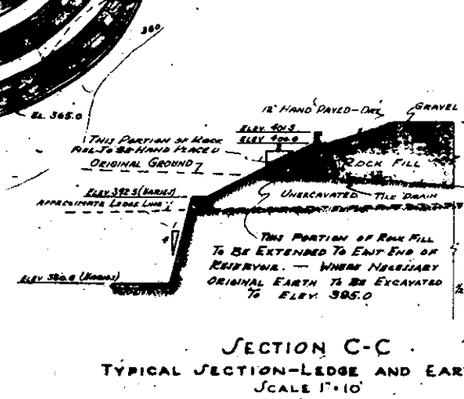

SECTION B-B
TYPICAL SECTION
SCALE 1" = 20'
0 20 40
FILL MUST BE THOROUGHLY COMPACTED TO AVOID SETTLEMENT ALONG BATTENS



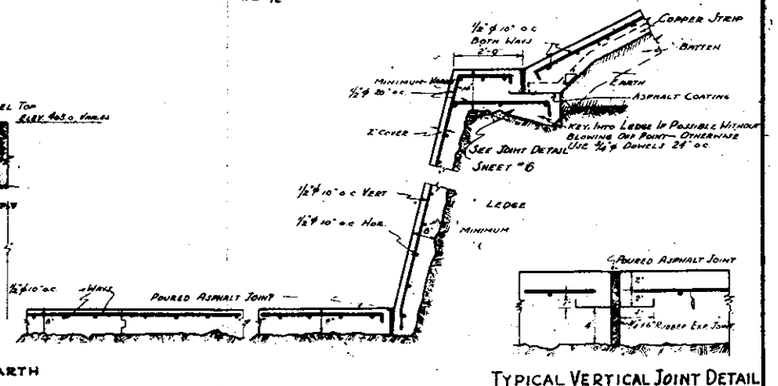

TYPICAL SLAB DETAIL ON EARTH
SCALE ½" = 1'-0"




TYPICAL JOINT L TYPICAL JOINT K
SCALE 1" = 1'-0"




SECTION C-C
TYPICAL SECTION-LEDGE AND EARTH
SCALE 1" = 10'




TYPICAL SLAB DETAILS ON LEDGE
SCALE ½" = 1'-0"




TYPICAL VERTICAL JOINT DETAIL AGAINST LEDGE
SCALE 1½" = 1'-0"




NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN

| No | Date | REVISION |
|---|---|---|
| 1 | 4/9/34 | TURNABOUT ADDED — N.E. CORNER |
| 2 | " | PARKING AREA ENLARGED |
| 3 | " | 2' DITCH — EAST SIDE ADDED |
| 4 | " | SECTION A-A CORRECTED |
| 5 | " | ROADWAY CULVERTS ADDED |
| 6 | " | SLAB ON EARTH CHANGED, STEEL ADDED |
| 7 | " | SLAB ON LEDGE — STEEL ADDED |
| 8 | " | JOINT: LOCATIONS CHANGED |
| 9 | " | FENCE PLACED |
| 10 | " | EARTH FILL SLOPE |
| 11 | 9/19/34 | SECTION C-C CHANGED |
| 12 | " | TYPICAL JOINT "K" CHANGED |

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ENGINEER

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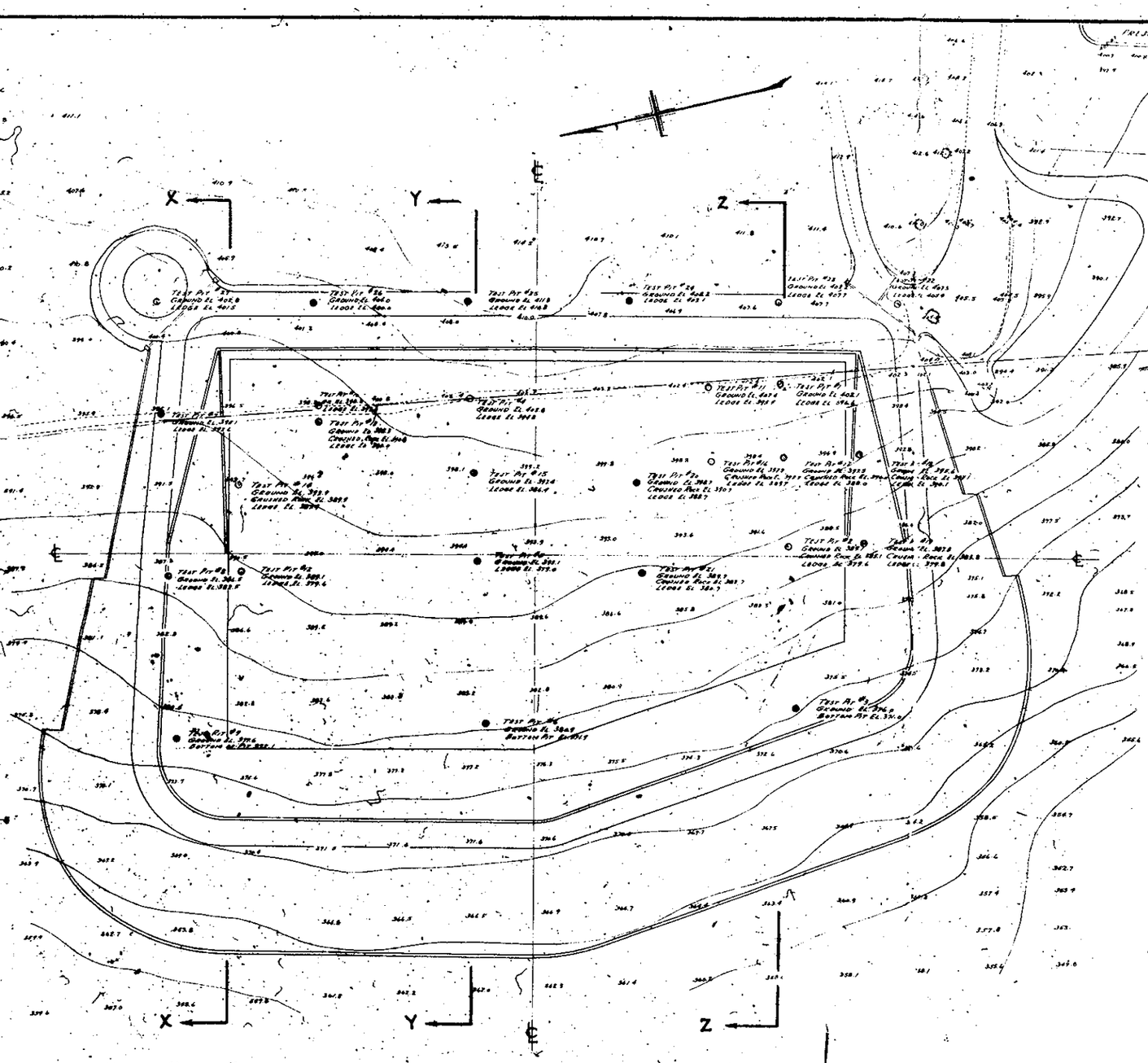
HIGH SERVICE DISTRIBUTION RESERVOIR
OAK HILL

# GENERAL LAYOUT SLAB & EMBANKMENT DETAILS

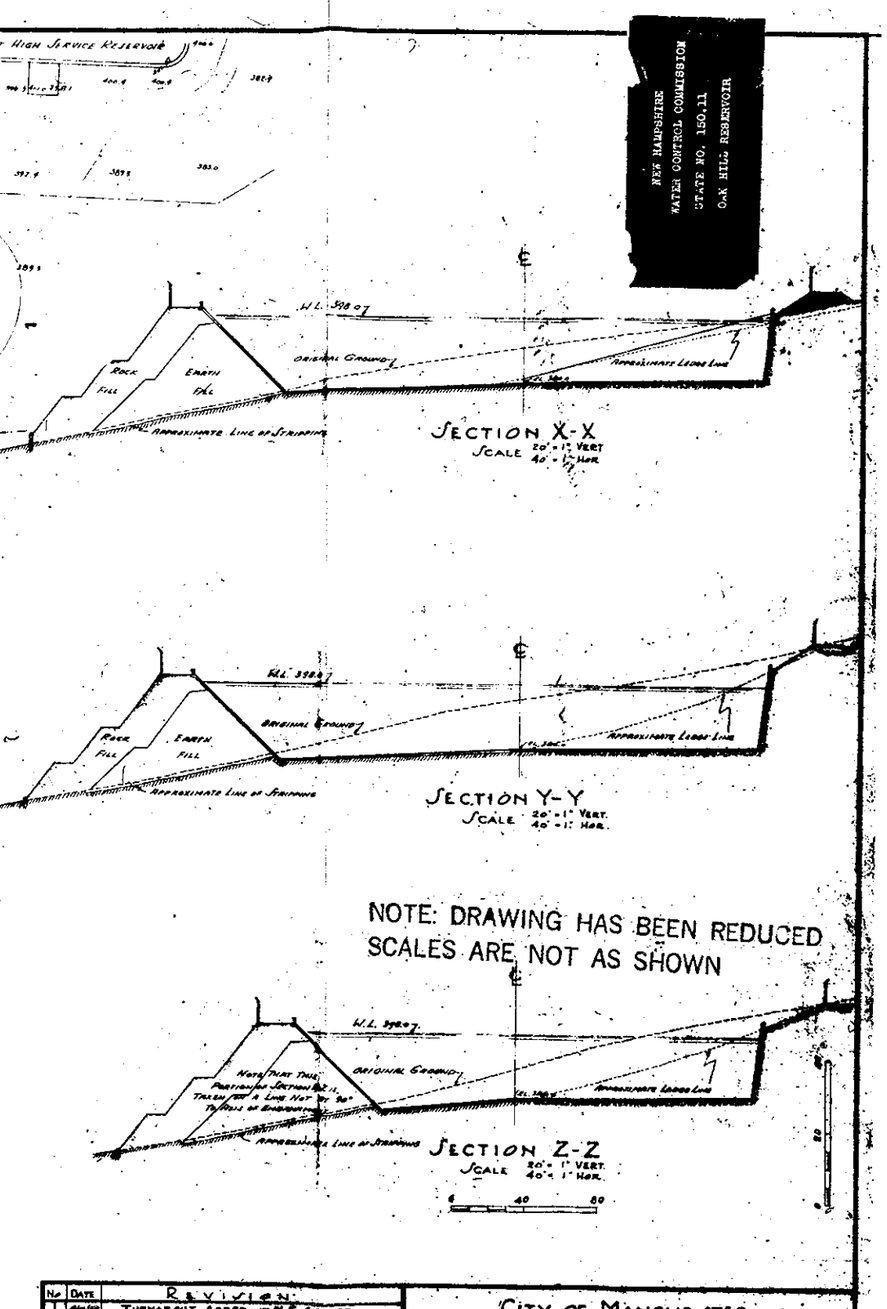
AUGUST 1, 1933 — SCALE 1"=NOTED

| DESIGNED | DRAWN | TRACED | CHECKED | NUMBER |
|---|---|---|---|---|
| | | | | 2 |

E DIMENSIONS - DO NOT SCALE




TOPOGRAPHIC PLAN
SCALE 1" = 40'




SECTION X-X
SCALE 20'-1" VERT.
40'-1" HOR.




SECTION Y-Y
SCALE 20'-1" VERT.
40'-1" HOR.

NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN




SECTION Z-Z
SCALE 20'-1" VERT.
40'-1" HOR.

| No | DATE | REVISION |
|---|---|---|
| 1 | 4/6/33 | TURNABOUT ADDED - N.E. CORNER |
| 2 | " | PARKING AREA ENLARGED |
| 3 | " | FENCE ADDED |
| 4 | " | ROADWAY CHANGED AT N.E. & S.E. CORNERS |
| 5 | | EARTH FILL SLOPE |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |

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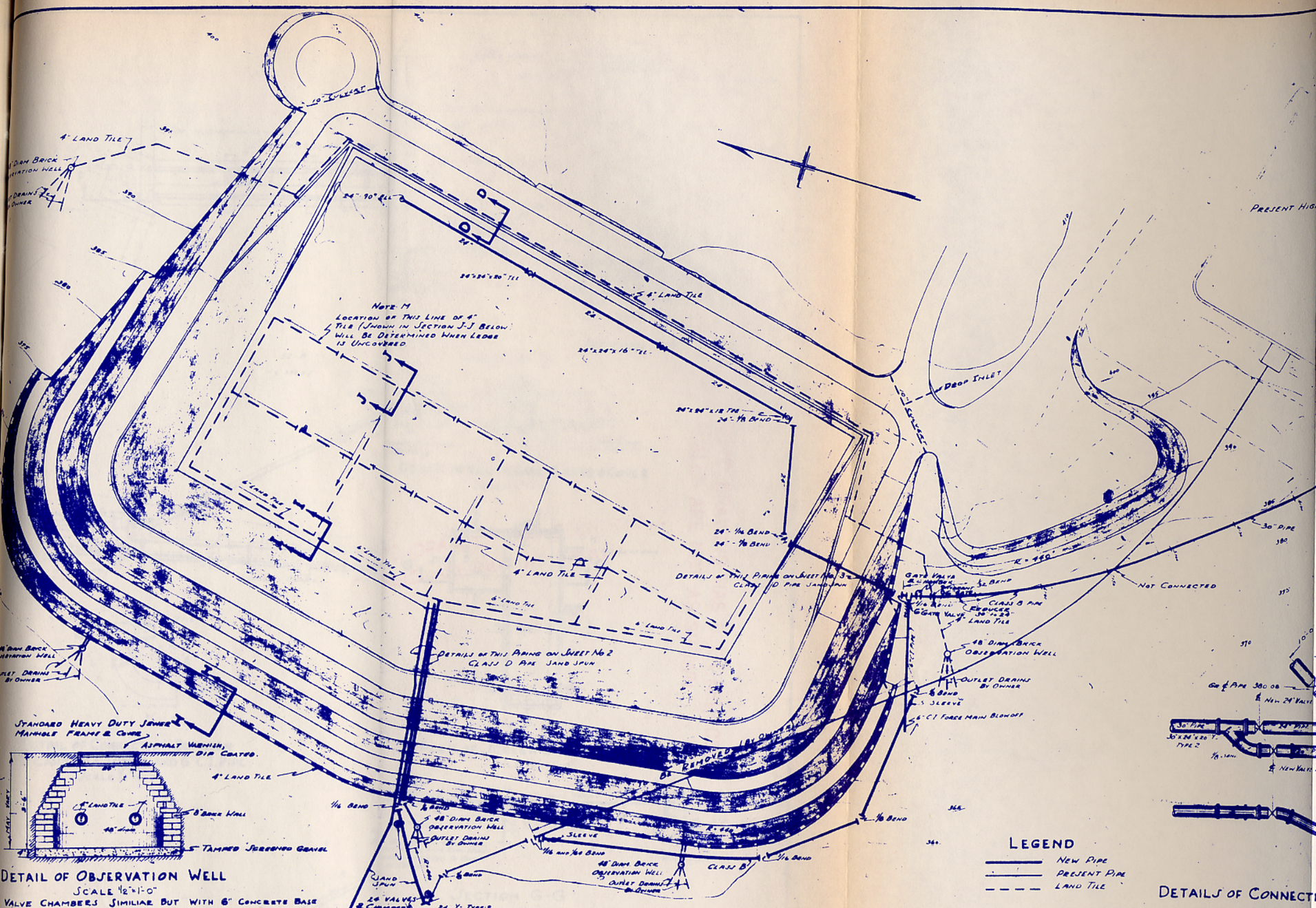
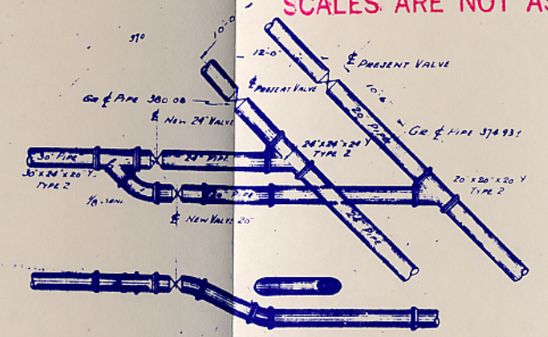
# TOPOGRAPHIC PLAN AND CROSS-SECTIONS

AUGUST 1, 1933 — SCALES - NOTED

| DESIGNED | DRAWN | TRACED | CHECKED | NUMBER |
|---|---|---|---|---|
| | | | | |

USE DIMENSIONS - DO NOT SCALE



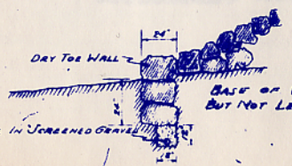

NOTE: DRAWING HAS BEEN REDUCED SCALES ARE NOT AS SHOWN

DETAIL OF OBSERVATION WELL
SCALE 1/2"=1'-0"
VALVE CHAMBERS SIMILIAR BUT WITH 6" CONCRETE BASE

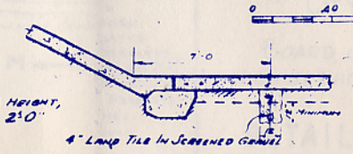
USE DIMENSIONS - DO NOT SCALE

PLAN OF PIPING AND DRAINS
SCALE 1" = 40'
0 40 80

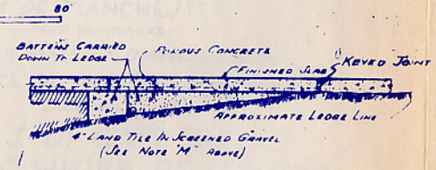
DETAILS OF CONNECTIONS 30" FORCE MAIN TO PRESENT 20" & 24" PIPE
SCALE 1/10 = 1'-0"



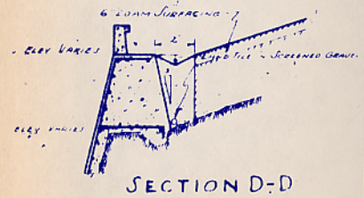

SECTION H-H
SCALE 1/4"=1'-0"




SECTION I-I
SCALE 1/4"=1'-0"




SECTION J-J
SCALE 1/4"=1'-0"




SECTION D-D
SCALE 1/4"=1'-0"

| No | DATE | REVISION |
|---|---|---|
| 1 | 4/20/34 | TURNABOUT ADDED N.E. CORNER |
| 2 | | PARKING AREA ENLARGED |
| 3 | | SECTION I-I CORRECTED |
| 4 | | SECTION D-D CORRECTED |
| 5 | | SLEEVES & VALVES ADDED ON BY PASS |
| 6 | | TYPE OF PIPE CORRECTED |
| 7 | 9/1/34 | OBSERVATION WELL DETAILS ADDED |
| 8 | | SECTION J-J JOINTS CHANGED |
| 9 | | EAST TILE DRAIN LOCATION CHANGED |
| 10 | | VALVE CHAMBERS & FORCE MAIN PIPE LINE DETAILED |
| 11 | | |
| 12 | | |

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[illegible] ENGINEER

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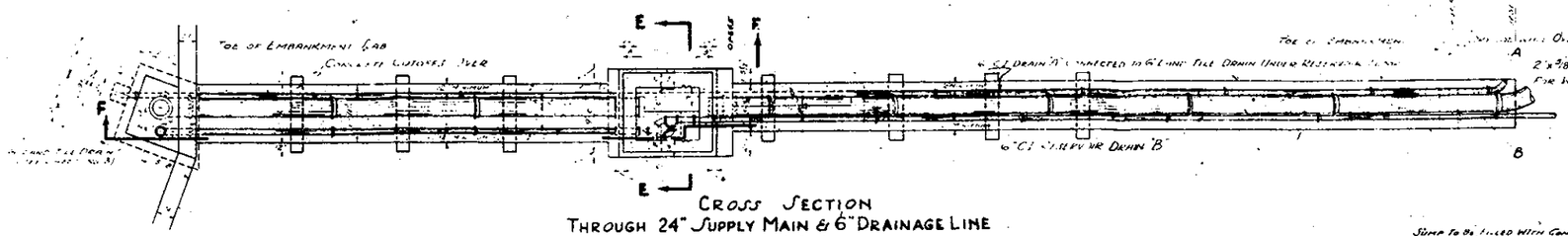
HIGH SERVICE DISTRIBUTION RESERVIOR
OAK HILL

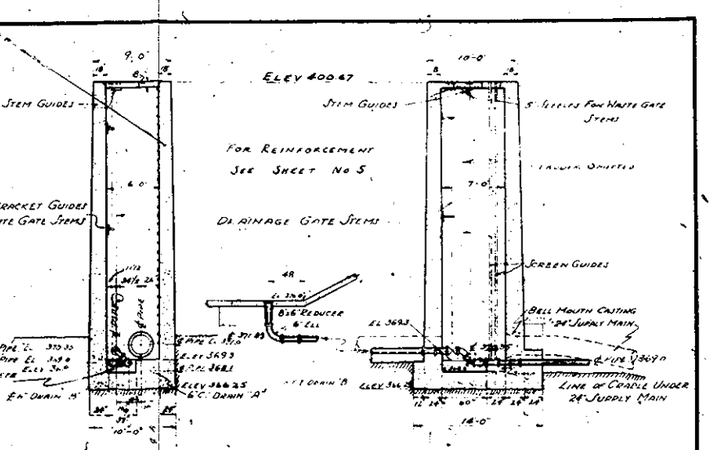
# PLAN OF PIPING AND DRAINS

AUGUST 1, 1933 — SCALE:- NOTED

| DESIGNED | DRAWN | TRACED | CHECKED | NUMBER |
|---|---|---|---|---|
| | | | | 4 |



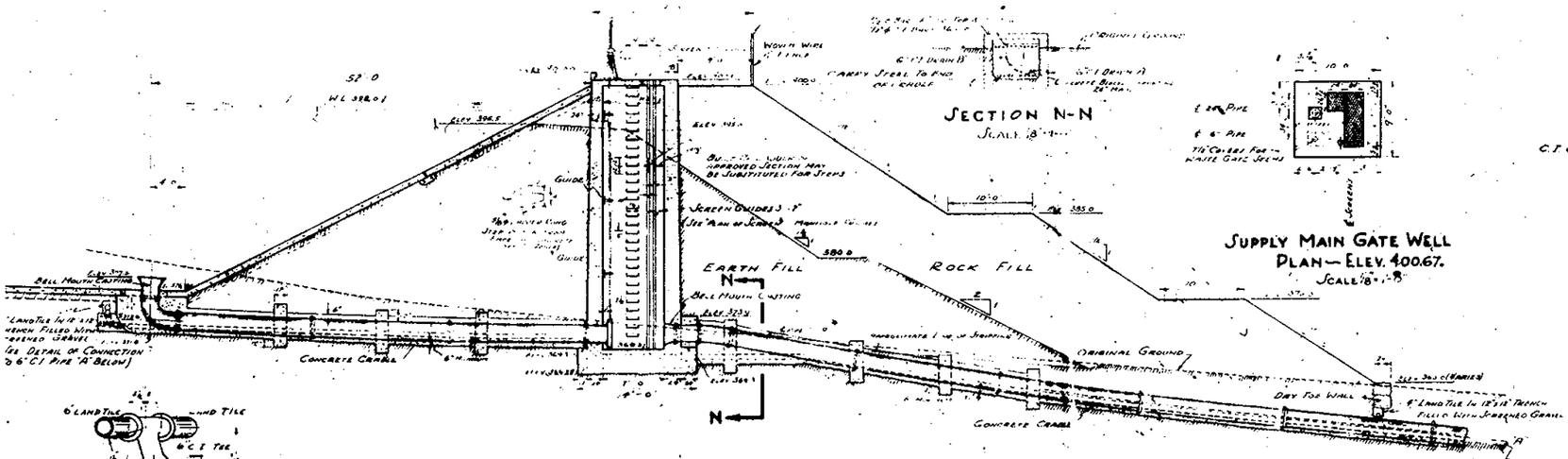

CROSS SECTION
THROUGH 24" SUPPLY MAIN & 6" DRAINAGE LINE
SCALE 1/8"=1'-0"




SECTION E-E
SCALE 1/8"=1'-0"

SECTION F-F

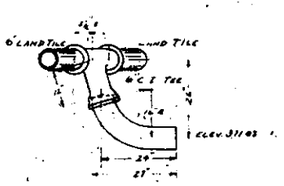

DETAIL OF WASTE GATE SLEEVE & COVER
SCALE 1"=1'-0"



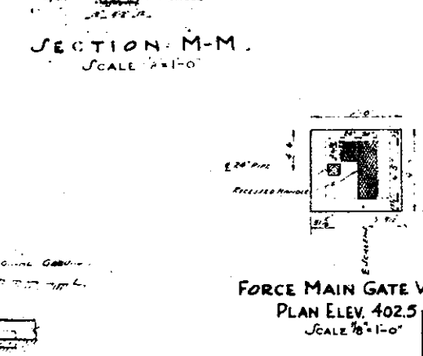

CROSS SECTION
THROUGH 24" SUPPLY MAIN & GATE WELL
SCALE 1/8"=1'-0"



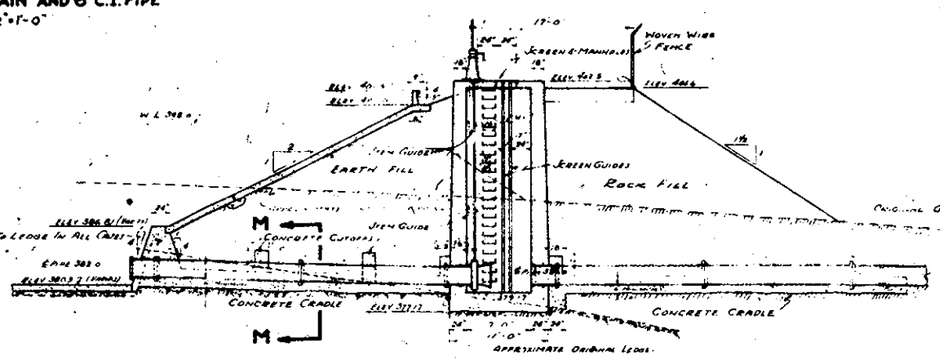

SUPPLY MAIN GATE WELL
PLAN — ELEV. 400.67.
SCALE 1/8"=1'-0"




DETAIL OF CONNECTION BETWEEN
6" LAND TILE DRAIN AND 6" C.I. PIPE
SCALE 1/2"=1'-0"



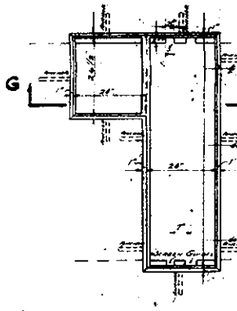

SECTION M-M.
SCALE 1/8"=1'-0"



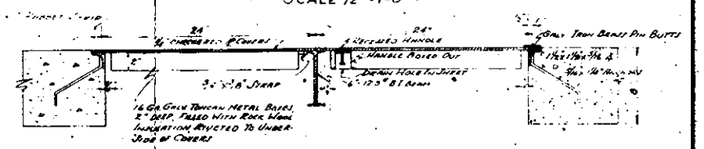

CROSS SECTION
THROUGH 24" FORCE MAIN & GATE WELL
SCALE 1/8"=1'-0"




FORCE MAIN GATE WELL
PLAN ELEV. 402.5
SCALE 1/8"=1'-0"




PLAN OF SCREEN & MANHOLE FRAMES
SCALE 1/2"=1'-0"




SECTION G-G
SCALE 1/2"=1'-0"

NOTE:
FORCE MAIN DETAILS — SHEET 6
SUPPLY MAIN DETAILS — SHEET 5

NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN

USE DIMENSIONS - DO NOT SCALE

| No | Date | REVISION |
|---|---|---|
| 1 | 6/1/34 | Bells & Cutoffs Rearranged |
| 2 | | Piping in Gatewell Rearranged |
| 3 | | Gate Stems & Guides Relocated |
| 4 | | 6" Tile — 6" C.I. Pipe Connection Corrected |
| 5 | | Supply Main Base Dropped to 366.25 |
| 6 | | Gatewell Plan Views Dimensioned |
| 7 | | Section G-G 6"12.5 B.I. Beam Redrawn |
| 8 | | Ladder Shown on All Drawings |
| 9 | | Joint on Slope & Fence Added |
| 10 | | Earth Fill Slope |
| 11 | | |
| 12 | | |

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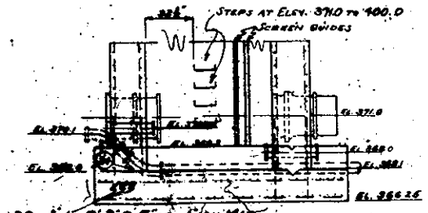
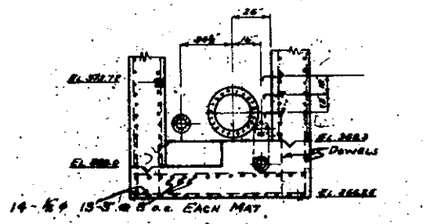
HIGH SERVICE DISTRIBUTION RESERVOIR
OAK HILL

# DETAILS OF GATE WELLS AND PIPING WITHIN RESERVOIR

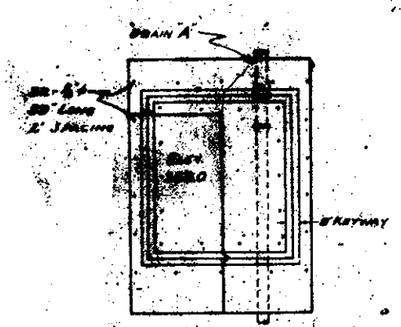
| August 1, 1933 | | | Scales - Noted | |
|---|---|---|---|---|
| Designed | Drawn | Traced | Checked | Number |
| | | | | 3 |



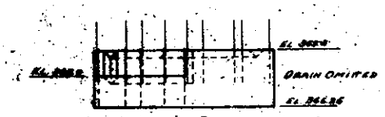

EAST - WEST SECTION
PIPES & STEEL
SCALE ¼"=1'-0"



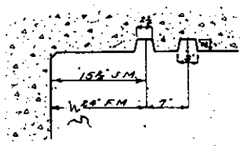

NORTH - SOUTH CROSS SECTION
PIPES & STEEL
SCALE ¼"=1'-0"



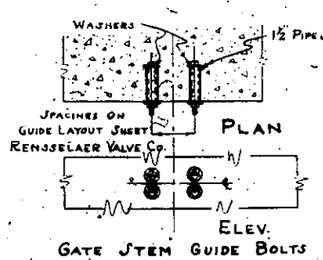

PLAN - ELEV. 369.3
DOWEL PLACEMENT & KEYWAY
SCALE ½"=1'-0"



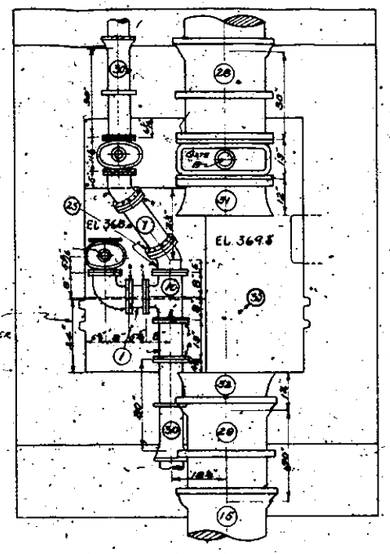

EAST END VIEW
ELEV. 369.3
SCALE ½"=1'-0"




DETAIL OF SCREEN GUIDES
SCALE 1"=1'-0"

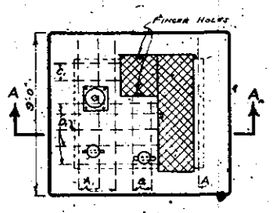



GATE STEM GUIDE BOLTS
IN CONCRETE
SCALE 1"=1'-0"

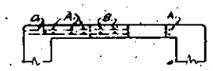



SUMP TO BE FILLED IN TO EL. 369.8 AFTER PIPES ARE PLACED

PLAN




PLAN ELEV. 400.67

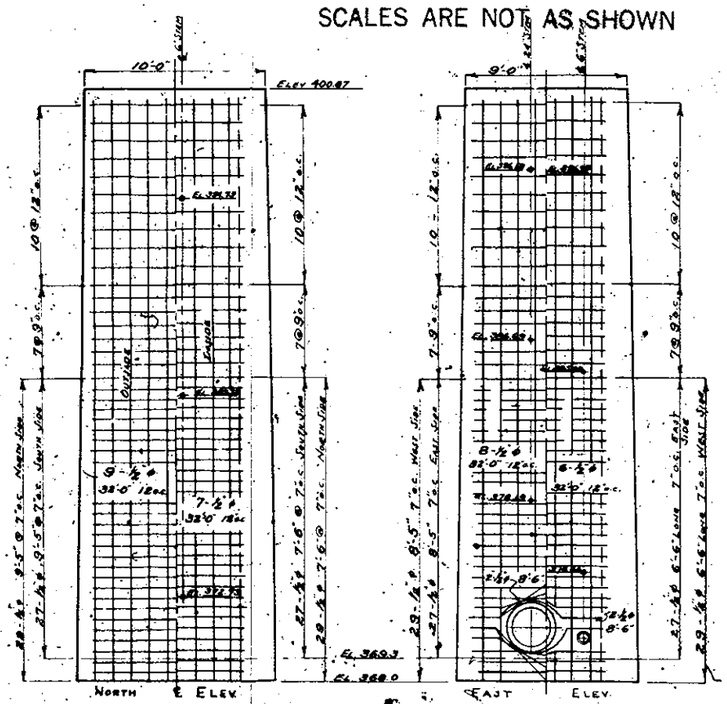


SECTION A-A

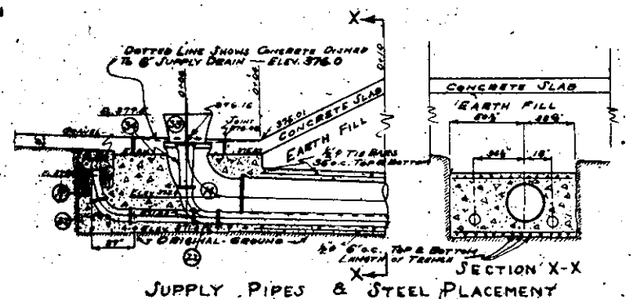
STEEL SCHEDULE

| | | | |
|---|---|---|---|
| $A_1$ | 8 - ½φ | 8'-8" | 4 TOP & 4 BOTTOM |
| $B_1$ | 4 - ½φ | 5'-2" | 2 TOP & 2 BOTTOM |
| $C_1$ | 4 - ½φ | 3'-6" | 2 TOP & 2 BOTTOM |
| $D_1$ | 10 - ½φ | 5'-6" | 5 TOP & 5 BOTTOM |

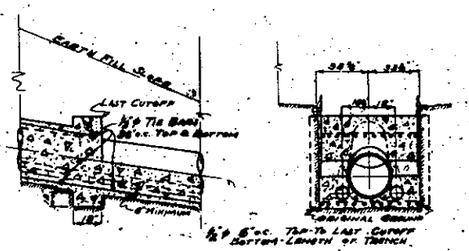
NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN



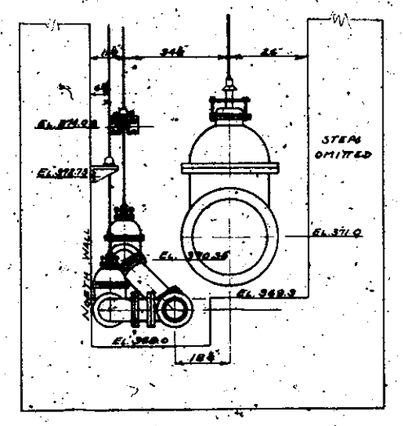

SUPPLY GATE WELL
STEEL PLACEMENT & STEM GUIDES
SCALE ½"=1'-0"




SUPPLY PIPES & STEEL PLACEMENT
SCALE ⅛"=1'-0"




SUPPLY PIPES
STEEL PLACEMENT
SCALE ⅛"=1'-0"




SUPPLY GATE WEL
PIPES & GATES
SCALE ½"=1'-0"
NOTE: DRAIN 'A' NOT INCLUDED

| No. | DATE | REVISION |
|---|---|---|
| | | |

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CITY OF MANCHESTER
NEW HAMPSHIRE
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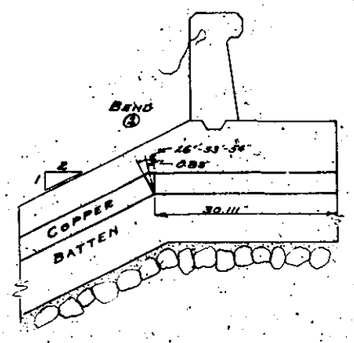
HIGH SERVICE DISTRIBUTION RESERVOIR
OAK HILL

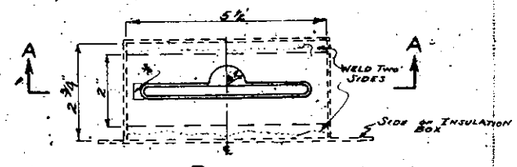
# DETAILS OF SUPPLY MAIN GATE WELL

MARCH 27, 1934 — SCALES NOTED

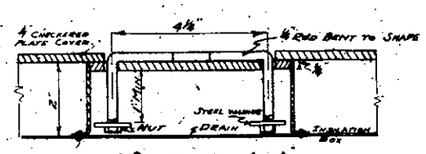
| DESIGNED | DRAWN | TRACED | CHECKED | NUMBER |
|---|---|---|---|---|
| | | | | 5 |



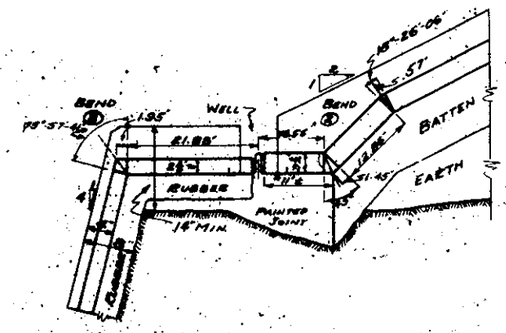

COPPER DETAIL — TOP OF BANK
SCALE 1"=1'-0"



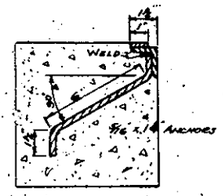

PLAN



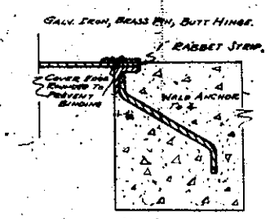

SECTION A-A
RECESSED HANDLE
SCALE ½"=1"




COPPER JOINTS + ROCK or EARTH
SCALE 1"=1'-0"

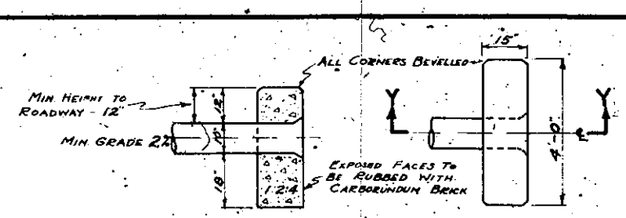



RABBET STRIP, ⅄ & ANCHOR

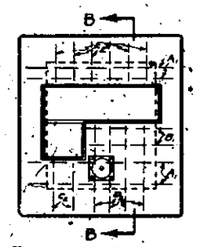



COVER HINGE.

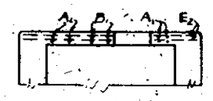
MANHOLE FRAME
SCALE 3"=1'-0"




SECTION Y-Y PLAN
V. C. PIPE CULVERT HEADWALL
SCALE ½"=1'-0"



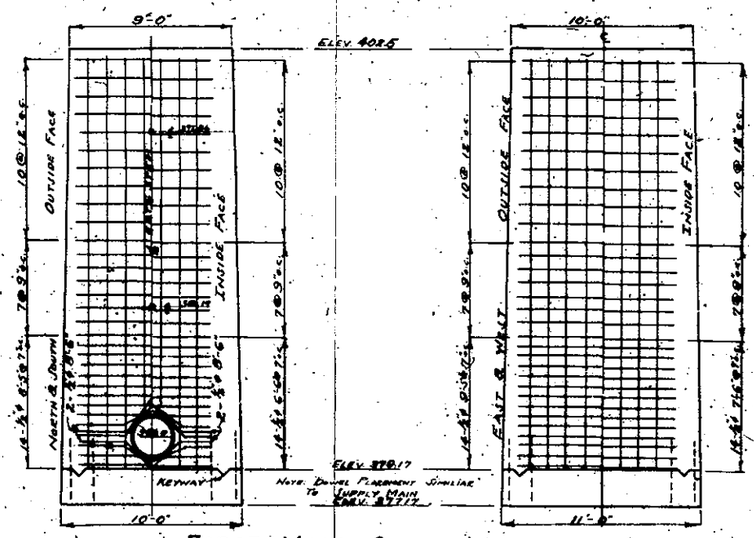

PLAN — ELEV. 402.5



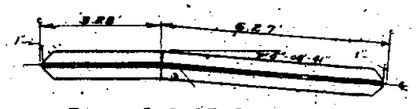

SECTION B-B

SCHEDULE

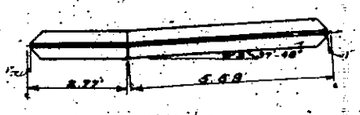
| | | | | |
|---|---|---|---|---|
| $A_1$ | 8-½"ø | 8'-8" | 4 Top | 4 Bottom |
| $B_1$ | 4-½"ø | 5'-2" | 2 Top | 2 Bottom |
| $C_2$ | 4-½"ø | 2'-10" | 2 Top | 2 Bottom |
| $D_2$ | 6-½"ø | 4'-10" | 4 Top | 4 Bottom |
| $E_2$ | 12-½"ø | 2'-6" | 6 Top | 6 Bottom |



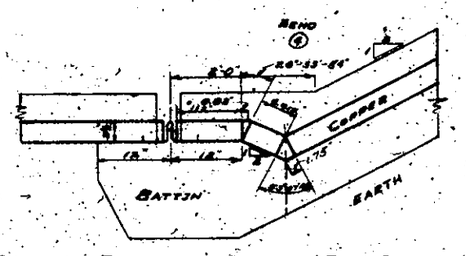

FORCE MAIN GATE WELL
STEEL PLACEMENT & STEM GUIDE
SCALE ¼"=1'-0"



JOINT S-6-65 DEVELOPED
SCALE ½"=1'-0"



JOINT S'-25'-6 DEVELOPED
SCALE ½"=1'-0"




COPPER — RESERVOIR BOTTOM EDGE JOINT
SCALE 1"=1'-0"

*NOTE: SEE JOINT KEY SHEET FOR DISTANCE FROM CENTER OF WELL TO NOSE OF JOINT

NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN

| No. | DATE | REVISION |
|---|---|---|
| | | |

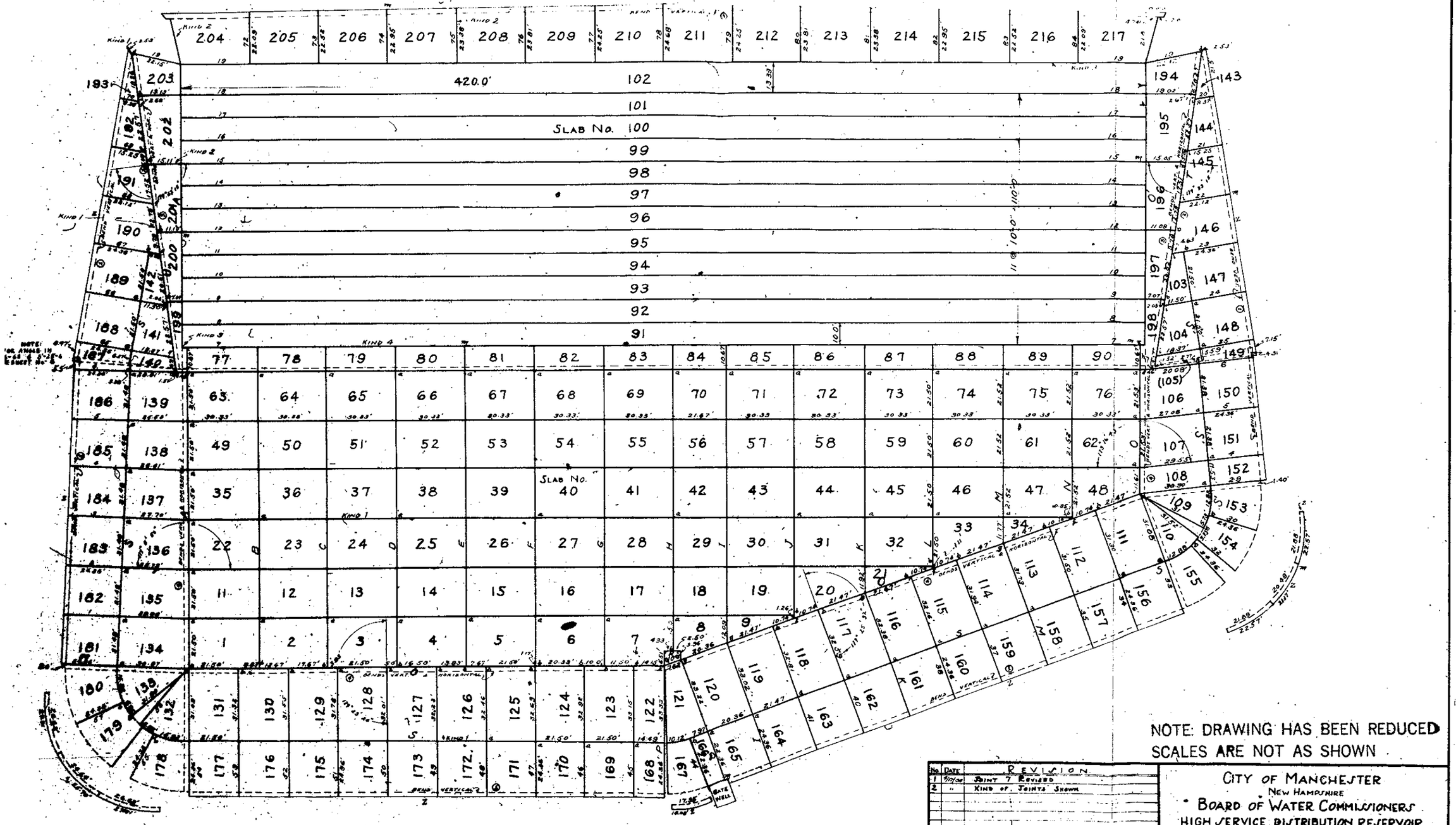
BOARD OF WATER COMMISSIONERS
Joseph Smith CHAIRMAN
O.K. Hare ENGINEER

CITY OF MANCHESTER
NEW HAMPSHIRE
BOARD OF WATER COMMISSIONERS
HIGH SERVICE DISTRIBUTION RESERVOIR
OAK HILL

# MISCELLANEOUS DETAILS

| DESIGNED | DRAWN | TRACED | CHECKED | NUMBER |
|---|---|---|---|---|
| | | | | 8 |

SCALES NOTED




NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN

| No | Date | Revision |
|---|---|---|
| 1 | 1/17/34 | Joint 7 Revised |
| 2 | " | Kind of Joints Shown |

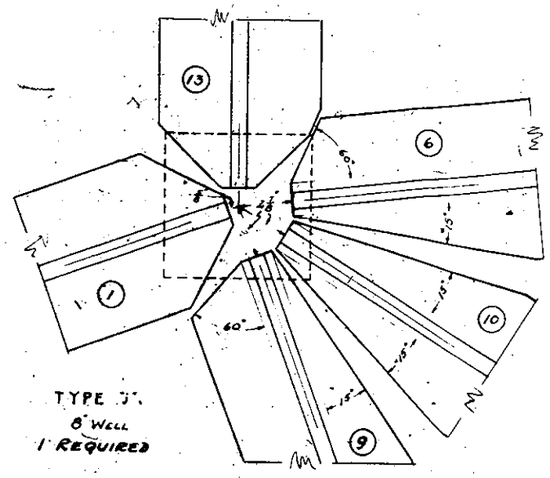
BOARD OF WATER COMMISSIONERS
J. Brodie Smith CHAIRMAN
P. H. Shaw ENGINEER

CITY OF MANCHESTER
NEW HAMPSHIRE
BOARD OF WATER COMMISSIONERS
HIGH SERVICE DISTRIBUTION RESERVOIR
OAK HILL

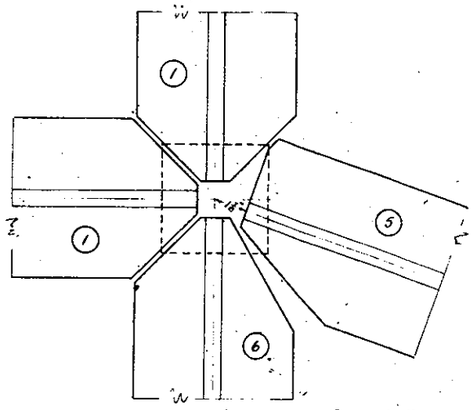
# DEVELOPMENT OF JOINTS IN RESERVOIR CONCRETE

MARCH 8 1934 — SCALE 1" = 20'

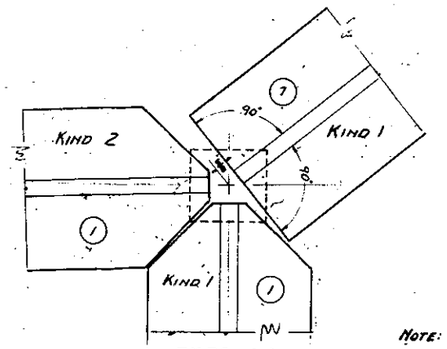
| DESIGNED | DRAWN | TRACED | CHECKED | NUMBER |
|---|---|---|---|---|
| | | | | 7 |




TYPE 'j'
8" WELL
1 REQUIRED

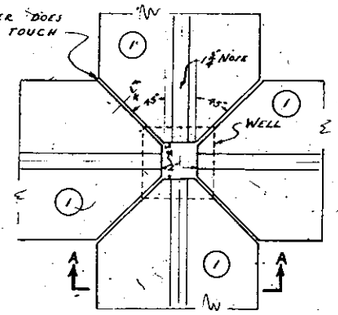



TYPE 's'
6" WELL
4 REQUIRED

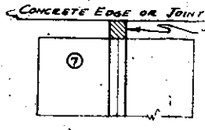



TYPE 't'
4" WELL
2 REQUIRED

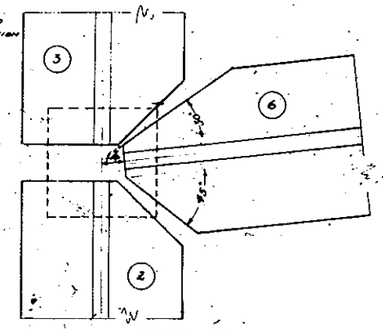
NOTE: SHAPE NO. aj - ○



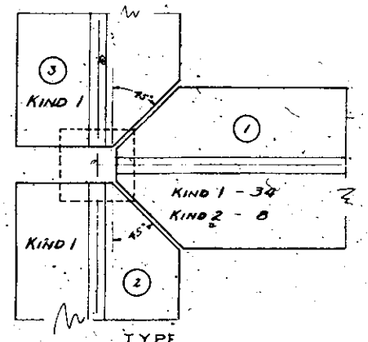

TYPE 'a'
4" WELL
115 REQUIRED




TYPE 'm'
65 REQ'D. KIND 1
26 REQ'D. KIND 2

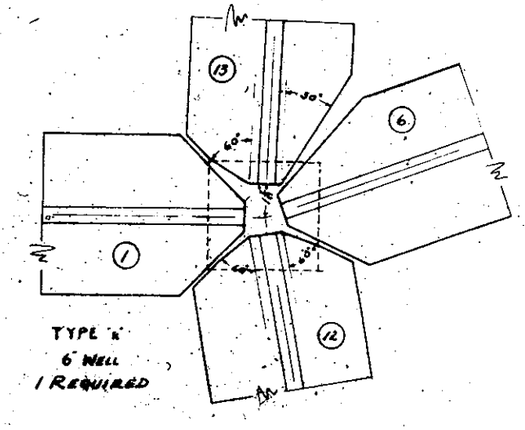



TYPE 'e'
6" WELL
1 REQUIRED

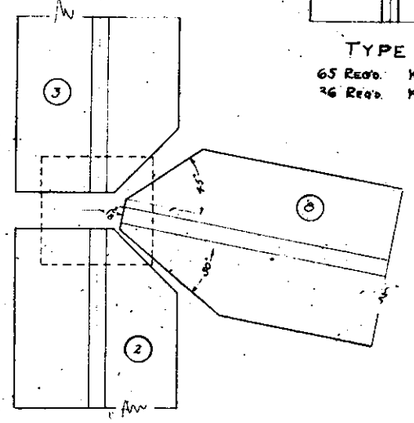



TYPE
4" WELL
42 REQUIRED

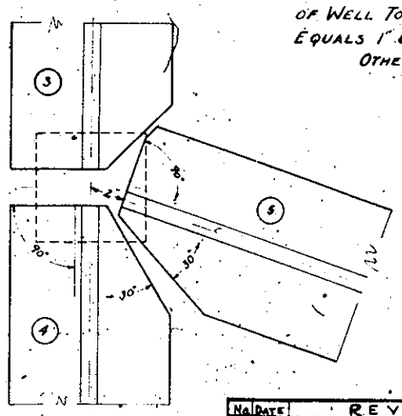
NOTE:- DISTANCE FROM CENTER OF WELL TO NOSE OF COPPER EQUALS 1" UNLESS SPECIFIED OTHERWISE.



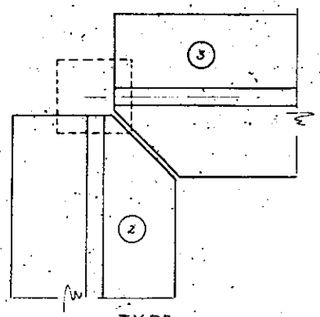

TYPE 'k'
6" WELL
1 REQUIRED



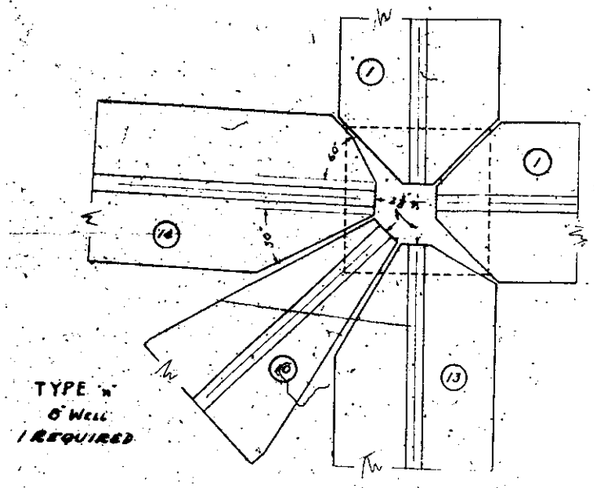

TYPE 'h'
6" WELL
1 REQUIRED



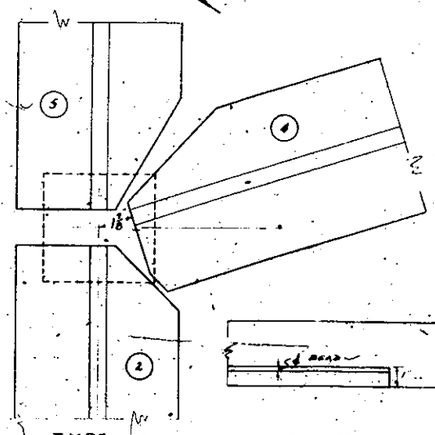

TYPE 'i'
6" WELL
9 REQUIRED




TYPE
4" WELL
2 REQUIRED



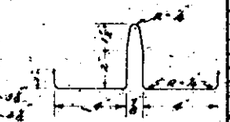

TYPE 'n'
6" WELL
1 REQUIRED




TYPE 'r'
6" WELL
6 REQUIRED




SIDE VIEW




SECTION A-A

NOTE: DRAWING HAS BEEN REDUCED SCALES ARE NOT AS SHOWN

| No. | DATE | REVISION |
|---|---|---|
| 1 | 1/1924 | TYPE 'm' ADDED |
| 2 | - | NO. REQ'D. CHANGED IN TYPES b & c |
| 3 | - | KIND OF JOINTS SHOWN IN TYPES b & d |
| 4 | | |

CITY OF MANCHESTER
NEW HAMPSHIRE
BOARD OF WATER COMMISSIONERS
HIGH SERVICE DISTRIBUTION RESERVOIR
OAK HILL

# JOINT SHAPES — INTERSECTION TYPES

BOARD OF WATER COMMISSIONERS
Patrick Smith CHAIRMAN
A. Shaw ENGINEER

MARCH 28, 1924 SCALE 3" = 1'

| DESIGNED | DRAWN | TRACED | CHECKED | NUMBER |
|---|---|---|---|---|
| | | | | 8 |

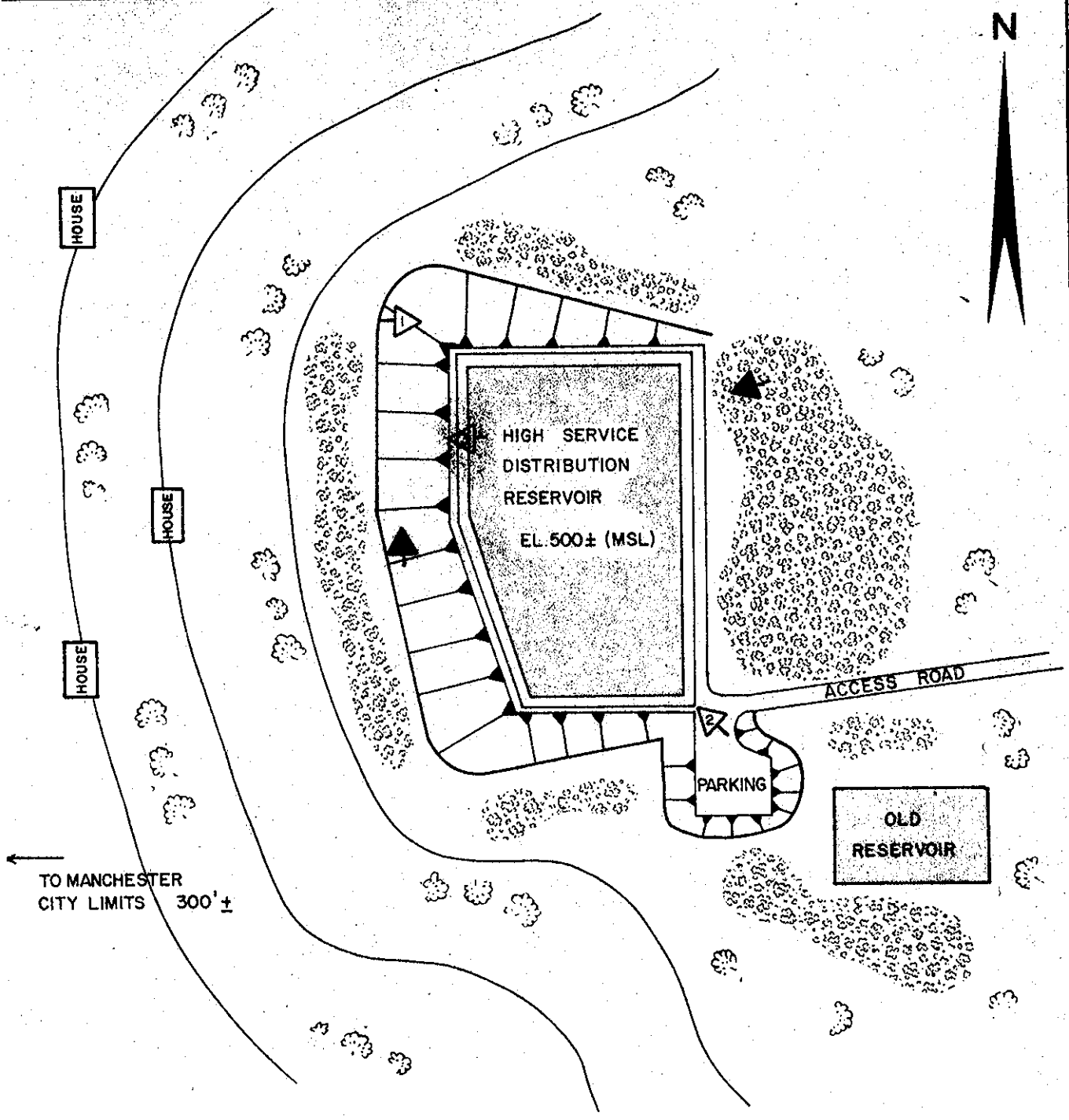
The New Hampshire Water Resources Board (NHWRB), 37 Pleasant Street, Concord, N.H. 03301, maintains a correspondence file on the reservoir. Included in the file are:

a) Inspection reports by NHWRB and New Hampshire Water Control Commission dated June 1978 and January 1950.

b) A questionnaire filled out for the New Hampshire Public Service Commission concerning the construction of the dam.

# APPENDIX C

SELECTED PHOTOGRAPHS




OVERVIEW

APPENDIX C

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

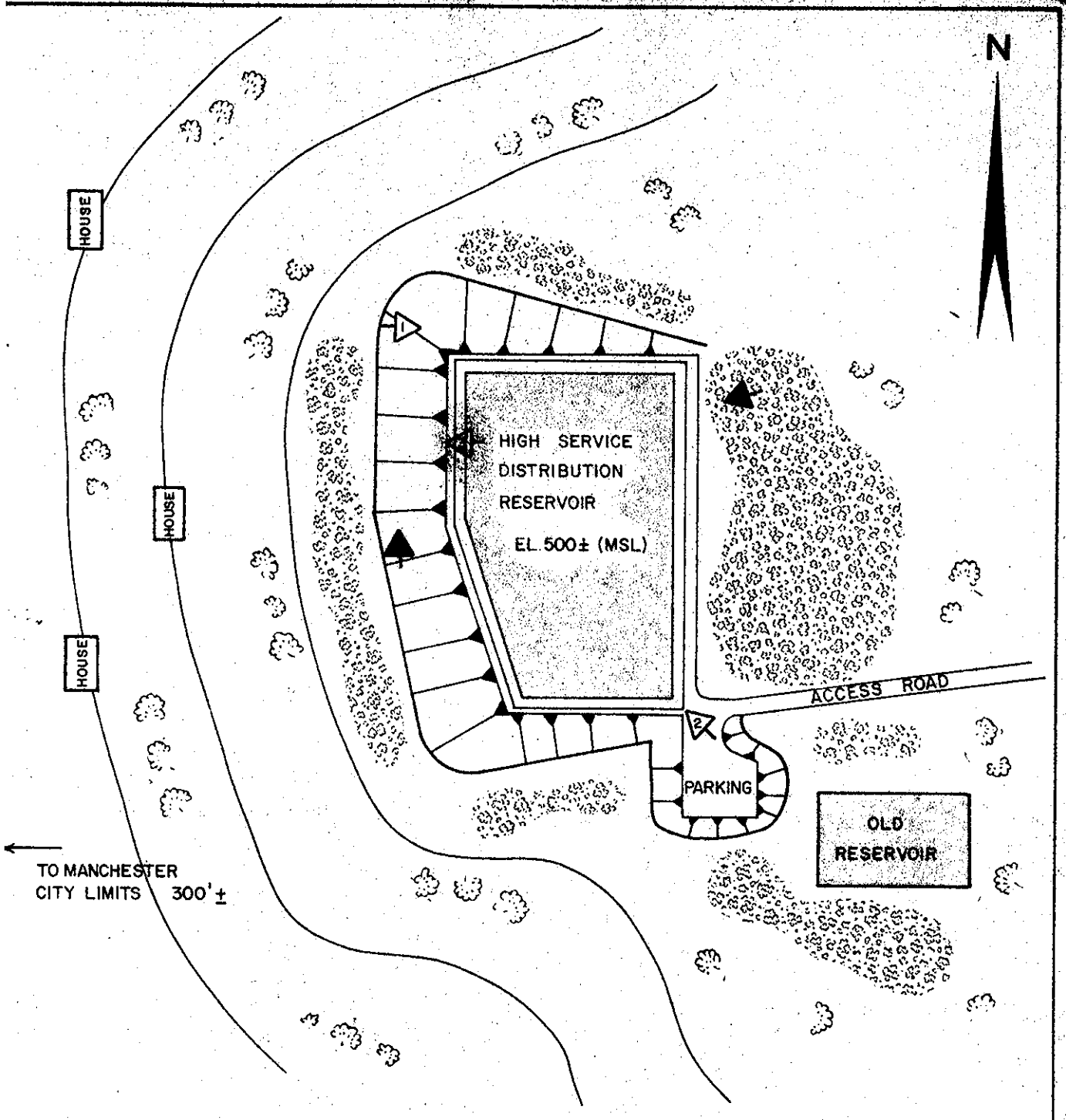
# LOCATION AND ORIENTATION OF PHOTOS

FILE No. 2201

H.S. DISTRIBUTION RESERVOIR NEW HAMPSHIRE

SCALE 1" ≈ 200'

DATE NOVEMBER 1978




OVERVIEW

APPENDIX C

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC.
GEOTECHNICAL CONSULTANTS
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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

# LOCATION AND ORIENTATION OF PHOTOS

FILE No. 2201

H.S. DISTRIBUTION RESERVOIR NEW HAMPSHIRE

SCALE 1" ≈ 200'

DATE NOVEMBER 1978

1. View of north side of reservoir showing poorer quality of slope protection at end of second tier

2. Detail of concrete lining and rubber membrane cover

3. Overview of area downstream of west side of reservoir from top of embankment

# APPENDIX D

## HYDROLOGIC/HYDRAULIC COMPUTATIONS

Stage-Discharge Curve-

Not applicable. Oak Hill Distribution Reservoir is a part of the Manchester Water Distribution System. It is a covered reservoir with no spillway and a 3.2 acre surface area. The inflow consists of a 24" force main from the water treatment plant on Massabesic Lake. The flow is controlled by an automatic system at the treatment plant, and can be operated manually. Outflow is through another 24" main, usually open, which connects to the Manchester supply system.

The mouth of the outlet faces up at elevation 478.3. The invert of the inlet is at 481.9. The top of the embankment varies from 500.9 to ~ 511. Normal operating range is between 494.9 and 498.9

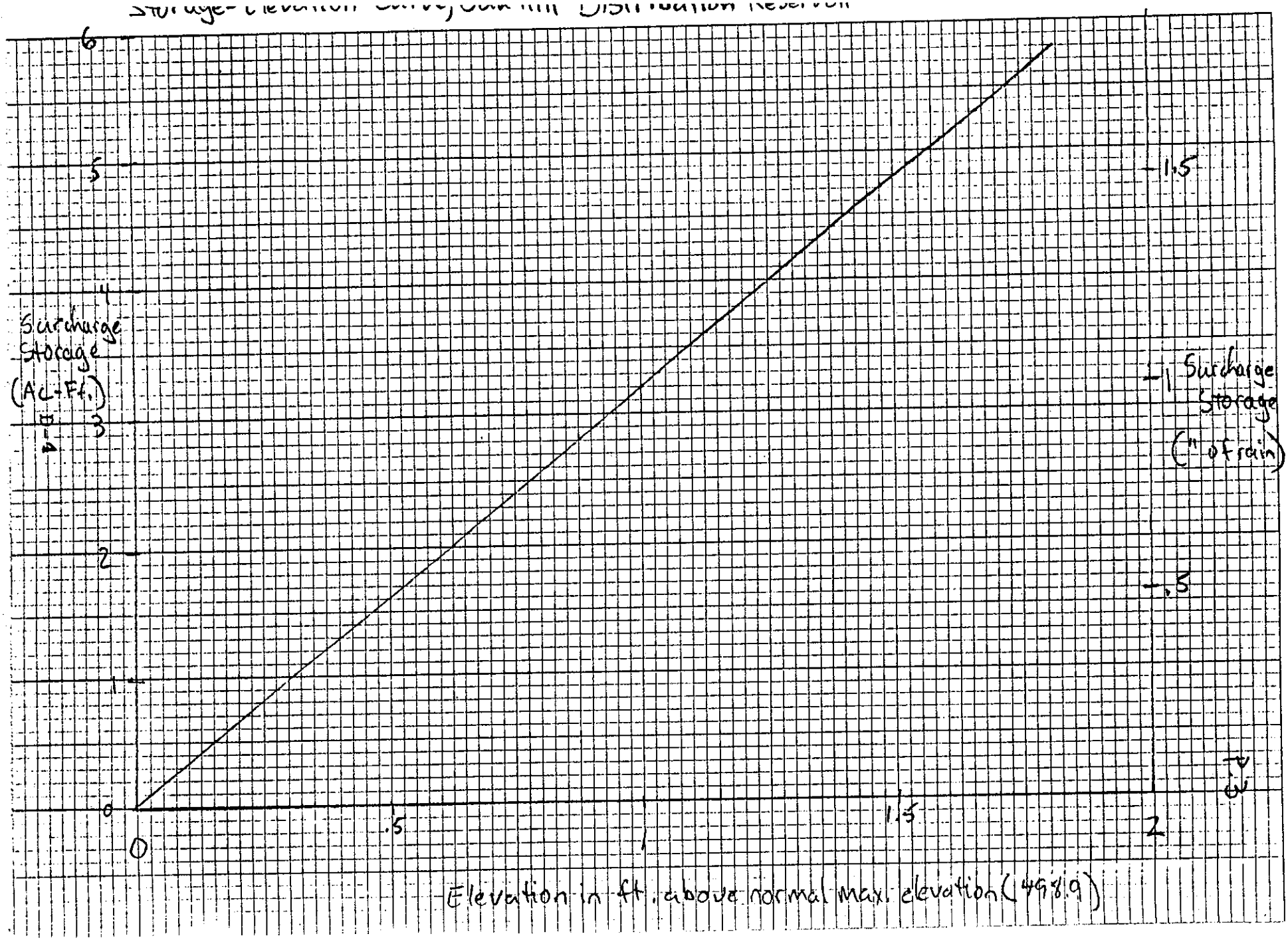
The perimeter of the embankment is 1570 ft (±).

Storage-elevation curve:

The surface area of Oak Hill Reservoir is about 3.2 acres. The storage-elevation curve on p. 3 assumes no spreading as the pond rises.

1" of runoff on 3.2 acres → 1" of rise.

So 1' of rise in the pond stores 12" of rain.

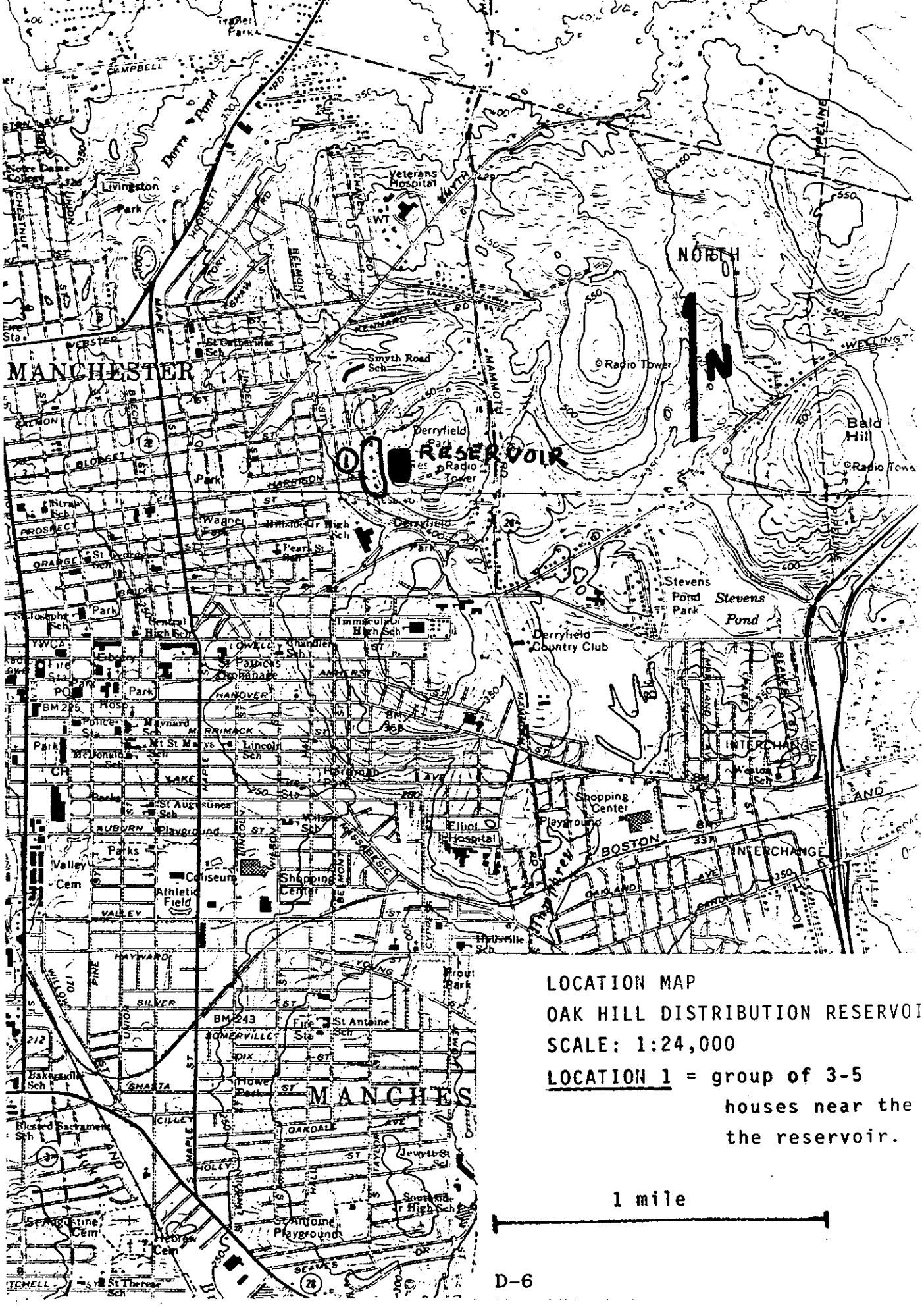

Storage-Elevation Curve for Bulk Mill Distribution Reservoir
Surcharge Storage (Ac-Ft.)
Surcharge Storage (" of rain)
Elevation in ft. above normal max. elevation (4918.9)
0
.5
1
1.5
2
3
4
5
6
.5
1
1.5
2

# Dam Failure Analysis

Due to the lack of a defined channel "downstream" of the embankment, it is difficult to predict the affects of dam failure. The only structures which might be affected by embankment failure are a group of house immediately to the west of the reservoir. These houses are about 100 ft. away down a steep (~30%) hill.

The Location Map on p.5 shows these houses in relation to the Reservoir.

If the west embankment of the reservoir were to fail, a 20-22ft. wall of water would be released down the hill. This would immediately begin to spread and attenuate. The water would hit the houses, and the flooding depth at this point might be expected to be between 1' and 5'. This would produce significant property damage and might produce some loss of life.




LOCATION MAP

OAK HILL DISTRICT RESERVOI

SCALE: 1:24,000

LOCATION 1 = group of 3-5 houses near the the reservoir.

1 mile

Test Flood Analysis

This dam could handle 24" of rainfall over its surface without overtopping.

Overtopping is more likely to occur by operator error than by rainfall.

# APPENDIX E

## INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS